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FOREIGN LIFE-SAVING ROCKETS AND ROCKET APPARATUS.

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REPORT

ON

FOREIGN LIFE-SAVING APPARATUS,

BY

Lieut. D. A. LYLE,
ORDNANCE DEPARTMENT, U. S. A.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1880.

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APPENDIX 14.

REPORT ON FOREIGN LIFE-SAVING ROCKETS AND ROCKET APPARATUS, 1880.

BY LIEUT. D. A. LYLE, ORDNANCE DEPARTMENT.

(Nineteen plates.)

NATIONAL ARMORY,
SPRINGFIELD, MASS.,
August 27, 1880.

SIR: I have the honor to submit herewith my report on foreign life-saving apparatus.

Nineteen plates, six of which are photographs, accompany the report.

Very respectfully, your most obedient servant,

D. A. LYLE,
First Lieutenant, Ordnance Department, U. S. A.

The CHIEF OF ORDNANCE, U. S. A.,
(Through the commanding officer of the National Armory.)

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This plate is an enlarged copy of the drawings that accompanied the letters patent
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Fig. 1 shows deviation of Boxer life-saving rocket and rocket line from the plane of fire due to the effect of the wind.
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Plate XIV

Shows Russian rocket, rocket stand, and method of firing.

Plate XV

Shows 5^{cm} German rocket, rocket stand, and method of firing.

Plate XVI

Shows 8^{cm} German rocket, rocket stand, and method of firing.

Plate XVII

Shows 8^{cm} German anchor rocket, rocket stand, and method of firing.

Plate XVIII

Shows English life-saving rockets, rocket stand, method of firing, fuse-box, portfire box, rocket-carrying box, faking box, and tripod for wreck light with light in position.

Plate XIX

Shows Hooper's life-saving rocket on the German stand, also effect of firing on Hooper rockets—one having the head blown out and the other being ruptured longitudinally.

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The writer is under great obligations to the Chief of Ordnance, U. S. A., for furnishing him with facilities for his labors and clerical assistance.

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I wish to express my thanks to Capt. J. H. Merryman, United States Revenue Marine, who placed at my disposal all papers in his hands relating to life-saving rockets, and assisted me by his experience with life-saving rocket apparatus.

I am under obligations to Capt. W. S. Starring, Ordnance Department, U. S. A., for assistance in experiments and photography, and the many courtesies extended to me while at Sandy Hook; to Lieut. Thos. D. Walker, United States Revenue Marine, assistant inspector life-saving stations, for valuable data and many other courtesies; and to Dr. V. McNally, for assistance in the preparation of the plates for printing.

Capt. John C. Patterson, keeper of life-saving station No. 1, district No. 4, and his crew, deserve especial mention for their zeal and the cheerful manner with which they underwent the toilsome labors during the experiments with the line-carrying apparatus. Captain Patterson brought to this labor skill and experience, together with a quick conception of the methods of manipulation rarely equaled. He assisted me throughout the experiments on the firing-ground, in taking inventories and in making the inspections and measurements.

I owe thanks to Samuel W. Porter, master armorer of national armory, for assistance in preparing for experiments; to Messrs. C. A. Emery, and S. C. Burnham, the former for making drawings of apparatus and the latter for printing.

D. A. LYLE,
Lieutenant of Ordnance.

NATIONAL ARMORY, *August* 25, 1880.

INTRODUCTORY NOTE.

In the spring of the year 1879, several lots of foreign life-saving rockets and rocket-apparatus which had been consigned to Capt. J. H. Merryman, United States Revenue Marine, inspector of life-saving stations, were sent by that officer to Sandy Hook, N. J., for examination and trial.

Instructions were given that inventories should be made of the apparatus, and that each article should be carefully inspected.

Lieut. D. A. Lyle, Ordnance Department U. S. A., was directed to make the inspection, and to familiarize himself with all the details of the several systems of apparatus. He was also directed to fire a few rockets of each kind in order to ascertain their condition as regards safety and efficiency.

It was deemed best to store these rockets in an ordinary building, open to sea-air for several months, in order to see what effect the salt air had upon the rocket cases.

In the latter part of the same year the examinations and trials were made.

The results with the Russian and Hooper life-saving rockets were so unsatisfactory that the firing with them was continued until the supply was exhausted.

It was decided that the other rockets should remain in store for at least another year, then to be examined and inspected.

Embodied in this report will be found descriptions of the different apparatus, together with the results of the experimental trials.

PART I.

INVENTORIES OF FOREIGN LIFE-SAVING ROCKET APPARATUS SENT TO SANDY HOOK, N. J., BY CAPT. J. H. MERRYMAN, UNITED STATES REVENUE MARINE, INSPECTOR UNITED STATES LIFE-SAVING STATIONS, FOR TRIAL AND EXPERIMENT.

I.—INVENTORY A.

Russian life-saving rockets and rocket apparatus.

No.	Name of article.
50	Russian life-saving rockets.
1	Rocket stand.
1	Port-fire holder.
1	Rocket chain.
1	Coil rocket line—loose twist—hemp.

II.—INVENTORY B.

German life-saving rockets and rocket apparatus.

No.	Name of article.
36	5cm German life-saving rockets.
36	5cm German life-saving rocket sticks and chains.
40	8cm German life-saving rockets.
40	8cm German life-saving rockets, sticks, and chains.
12	8cm German anchor rockets.
12	8cm German anchor sticks and chains.
4	German rocket stands.
4	German faking boxes and lines.
4	Firing staves or *pillenlichte* holders.
4	Firing locks.
100	*Pillenlichte.*

III.—INVENTORY C.

Boxer life-saving rockets and rocket apparatus (English).

No.	Name of article.
216	Boxer 12-pounder life-saving rockets.
216	Boxer 12-pounder life-saving rocket sticks.
216	Iron pins for attaching rockets to sticks.
216	Brass washers.
216	India-rubber washers.
12	Rocket stands or machines, "Mark IV."
12	*Boxes, wood, for port-fires.
48	Boxes for carrying single rockets, with braces.
288	Port-fires in tin cylinders, of 24 port-fires each.
1	Box rocket fuses.
36	Lights for illuminating wrecks.
12	Stands or tripods for lights illuminating wreck.

*Each of these boxes will carry 24 port-fires, 30 detonating primers in a small cylinder, and 2 port-fire holders. No primers or holders were sent with the apparatus.

IV.—INVENTORY D.

Hooper's life-saving rockets.

No.	Name of article.
24	Hooper life-saving rockets.
30	Pieces of slow match.

NOTE.—No stand was found with these rockets.

PART II.

RUSSIAN LIFE-SAVING APPARATUS.

I.—RUSSIAN LIFE-SAVING ROCKET.

(Plate I.)

1.—DESCRIPTION.

The Russian life-saving rocket is made of sheet iron, about one-tenth (0″.1) of an inch in thickness. The body is a cylindrical tube, closed at the front end by a metallic head, held in position by four short screws.

The rear end is closed by a diaphragm, which is perforated by six vents or fuse holes, equidistant circumferentially, whose centers are on the circumference of a circle concentric with the diaphragm.

An axial hole in the diaphragm has a female screw thread cut on its interior surface to engage the male thread on the rocket stick.

The body is fastened to the perforated disk by crimping and by short iron pins. The cylinder is filled with rocket composition.

The construction of the rocket stick is shown in Fig. 4. The body of the stick is made of light wood, cylindrical near the base and tapering to the front, forming the frustum of a cone. The front end of the stick, which screws into the rocket, is made of wrought iron, hollow at its base for the insertion of the wooden body. The latter is held in place by screws. The rear end of the body is rounded, and on one side carries a strong iron hook, about five (5″) inches in length, with its point turned towards the front, and curved slightly outwards from the axis of the stick.

A curved steel spring is placed between the point of the hook and the shank strap to prevent the egress of the ring of the rocket chain after firing. This hook is bolted to the wooden body of the rocket stick, as shown in the figure.

When prepared for packing, the rocket sticks are screwed into the rockets and the fuse holes or vents are covered by disks of water-proof tarred cloth.

The diameter of the disk is enough larger than that of the rocket to admit of its being folded over the end of the rocket and secured by several turns of twine, tied tightly around it.

The whole rocket, except the wooden body, is then treated with a coat of black paint.

The cap or disk must be cut away before firing, in order to expose the fuse holes.

2.—PRINCIPAL DIMENSIONS, WEIGHTS, ETC.

		Inches.	Centimeters.
Rocket body	Length	25.25	64.12
	Exterior diameter	3.2	8.13
	Interior diameter	3.0	7.62
Total length of rocket		27.2	69.08
Total length of rocket stick		29.2	74.16
Total length of rocket and stick		55.5	140.97
Length filled with composition		23.1	58.67
Maximum diameter of stick		2.8	7.11
Diameter of vents or fuse holes		0.6	1.52

Number of vents, six.

	Pounds.	Kilos.
Average weight of rocket and stick	25.5	11.56

For detailed dimensions and method of construction, see Plate I.

3.—PACKING.

The rockets, with sticks attached, are packed in boxes containing five each. The boxes are very heavy, and are made of 2-inch plank.

Clamps are placed at each end of the box, and are notched to fit the rockets. A strip of felt is placed along the edge of each clamp above and below the rocket.

The lid has two hinges on one side so that the box may be opened, the rockets used, and the box refilled. Screws hold the top securely to the sides in transportation.

An annealed iron wire passed through the side and top of the box on the edge opposite the hinges, has the ends drawn together and held firmly by a leaded seal put on by the inspecting officers of the Imperial Russian Government. This prevents tampering with the contents without detection. The seal bears the date of packing (1876).

The boxes were covered with coarse felt an inch or more in thickness, over which was a wrapping of gunny sacks and matting; the whole firmly bound with hemp cordage.

II.—RUSSIAN LIFE-SAVING ROCKET STAND.

(Plate II.)

1.—DESCRIPTION.

This stand is a rectangular tube of sheet-iron mounted upon a wooden tripod. The cross-section of the tube is a square with one of its diagonals situated in a vertical plane when the stand is in position for use. This hollow parallelopipedonal tube is formed from a single piece of sheet-iron. The longitudinal faces forming the lower edge do not join to complete the regular figure, except for two (2″) inches at the lower end, but are bent outwards from each other, forming two parallel flanges, Figs. 1 and 4. These flanges are 1″.7 wide, and have a space half an inch wide between them throughout their length.

The space between the flanges serves as a channel for the grappling hook on the under side of the rocket-stick to slide in when the rocket is fired.

It is also necessary for the same purpose in placing the rocket in position before firing.

The rear end of the square tube is bound and strengthened by a band of strap iron 2″ wide and one-tenth (0″.1) of an inch thick.

The front end of the tube is reinforced in a similar manner, but with

this difference: The band at its lower edge has a cylindrical tube (Figs. 1, 2) 1″.7 in diameter, projecting to the front 2″.3, for the purpose of holding the ring of the rocket chain.

This short tube embraces the front ends of the flanges of the body, and has a longitudinal slot, corresponding in width to the space between the flanges along its upper surface to permit the passage of the rocket hook.

A rectangular notch 1″.1 deep is cut in the lower side to accommodate the upper link of the rocket chain when the ring is placed over the projecting tube.

Near the middle of the longitudinal bottom flange on the right-hand side of the body tube is attached a rectangular brass plate, 10″ long and 1″.6 wide, with a lug and eye-hole projecting from its under edge near the middle. Through this eye-hole passes the horizontal axis.

In a corresponding position on the left side is a semicircular brass plate attached to the other flange. The arc of this plate is graduated into degrees, in order to indicate the elevation of the axis of the main tube.

A lug and eye-hole at the center of this arc admits of the insertion of the horizontal axis.

A slotted brass support (G, Figs. 1 and 4) with holes pierced through the upper ends of the vertical arms sustains the horizontal axis (C, Figs. 1 and 4) that carries the rocket tube (T, Figs. 1 and 4) and its graduated arc.

A clamp screw (A, Fig. 4) passes through this support from the right side and clamps the arc in any given position. All motion in altitude within the limits of the scale is governed by this screw. The lower end of the support (G, Fig. 4) terminates in a cylindrical tenon 3″.2 in length and 1″.2 in diameter, which fits in a corresponding hole in the tripod head (H, Fig. 5).

A shoulder (S, Fig. 4) on the support rests upon the top of the tripod-head when the clamp screw (B, Figs. 1 and 5) is loosened.

The tripod (Fig. 5) is composed of a head (H), three legs and a clamp screw (B).

The head is of brass. This piece is a hexagonal prism in form, with narrow longitudinal projections, or lugs, on the alternate faces for the attachment of the legs.

These projections are 120° apart. Opposite one of them is a rectangular seat through which the clamp screw (B, Fig. 5) passes that controls the motion in azimuth and the limited vertical motion of the support and its superincumbent weight.

The head is pierced longitudinally by an axial hole for the reception of the tenon of the support. The legs are made of wood, shod at their lower ends with pointed iron shoes, and encircled by narrow iron bands near their upper extremities.

The upper ends of the legs are slotted vertically to receive the projections on the *head*, to which they are fastened by iron pins.

Two elliptical openings (E, Figs. 1 and 2), opposite to each other, are made in the upper sides of the tube for the insertion of the port-fire to ignite the rocket composition.

2.—PRINCIPAL DIMENSIONS, WEIGHTS, ETC.

		Inches.	Centimeters.
Total length of rocket-tube		53.3	135.38
Cross-section, square..	Exterior	4.3	10.92
	Interior	4.1	10.41

	Pounds.	Kilograms.
Weight of rocket stand	39.0	17.69
Weight of rocket chain	4.625	2.17
Weight of port fire handle	0.5625	0.25
Total weight without packing box	44.1875	= 20.13
Weight of coil of rocket line	62.0	28.12

For other details, see Plate II.

3.—PACKING CASE FOR ROCKET STAND.

The rocket stand and port-fire holder are securely packed in a long box with a hinged lid, closed by a hasp. This box has a handle at each end for convenience in transportation.

4.—DIMENSIONS AND WEIGHT.

		Inches.	Centimeters.
Exterior dimensions of box for rocket stand	Length	69.0	175.26
	Width	16.375	41.65
	Depth	9.5	24.13

	Pounds.	Kilograms.
Total weight of box and stand	99	44.90
Weight of packing box	60	27.21

III.—PORT-FIRE HOLDER.

(Plate II, Fig. 7.)

A port-fire holder or firing staff accompanies the rocket stand. It is a simple wooden handle with a bent head of brass. The brass head is hollow and is slitted on the sides so as to form a rude clamp. The port-fire is inserted in the split end of the head and then ignited in the usual manner.

IV.—ROCKET CHAIN.

(Plate I, Fig. 7.)

This is a hand-made iron chain, six (6′) feet in length, terminated at one end by a ring two (2″) inches in diameter. The ring is placed over the tubular projection on the front end of the rocket stand in firing. The other end of the chain is fastened to the end of the rocket line.

V.—ROCKET LINE.

This is a loosely-twisted hemp line about the size of the No. 8 or No. 9 service lines. The Russian method of coiling or faking the line is unknown, as no instructions were received with the apparatus.

VI.—METHOD OF USING.

The rocket stand is taken from the box, the legs of the tripod extended, and the stand placed at the firing point. The index being clamped at zero on the graduated arc, the tripod is leveled by the eye by making the axis of the rocket tube horizontal. This can only be done approximately; then loosen the lower clamp screw and swing the stand around until it points in the desired direction. Clamp the vertical spindle and by turning the upper clamp screw to the left the required elevation may be given; after which the screw must be tightened, in order to retain the tube in place. Take a rocket from its box, tear off

the cap over the vents, insert the rocket, base first into the rectangular tube with the hook on the stick gliding down between the flanges on the lower side of the tube. When the hook strikes the band at the lower end of the rocket tube, the rocket is in position for firing. Place the fakes or faking box in front of the stand, put the ring of the chain over the cylindrical tubular projection on the front end of the stand, letting the chain attached to the line hang below. Stand clear of the line, and, with a port-fire inserted in the holder, advance and ignite the rocket by thrusting the port-fire gently through one of the elliptical openings in the rocket tube. Care must be taken not to disturb the aim.

VII.—ACTION.

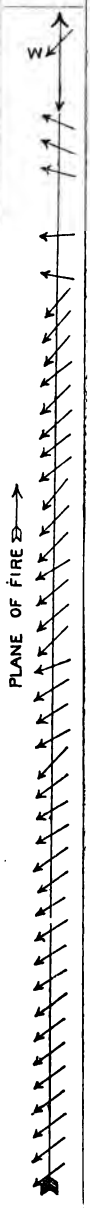
An instant after the composition in the base of the rocket is ignited, the latter leaps forward guided by the rocket tube, and as it leaves the tube the hook engages the ring of the chain attached to the line and carries out the chain and line.

The chain should be fastened to the line in advance, before it is wanted for use.

VIII.—EXPERIMENTS WITH LIFE-SAVING APPARATUS AT SANDY HOOK, N. J.

1.—*Record of firings with Russian life-saving rockets and apparatus.*

Date.	Number of fire.	Elevation.	Kind of rocket stand.	Rocket, kind of.	Primer.	With what fired.	Where fired.	Line attached or not.	Rocket exploded in air or not.	Wind. Direction.	Wind. Velocity.
1879.		°									
Oct. 18	1	32	Russian	Russian life-saving rocket.	None	Port-fire (English).	Down beach	Yes	Yes.	W	
18	2	35	...do	...do	...do	...do	Out to sea	No.	Yes.		
18	3	35	...do	...do	...do	...do	...do	No.	Yes.		
18	4	30	...do	...do	...do	...do	...do	No.	No.		
20	5	43	...do	...do	Quick-match.	...do	Down beach	No.	Yes.		
20	6	43	...do	...do	...do	No further record of this rock't					
22	7	35	...do	...do	...do	Port-fire (U. S.)	Out to sea	No.	Yes.		
22	8	35	...do	...do	...do	...do	...do	No.	Yes.		
22	9	35	...do	...do	...do	...do	Down beach	No.	Yes.		
22	10	35	...do	...do	...do	...do	...do	No.	Yes.		
22	11	35	...do	...do	...do	...do	...do	No.	Yes.		
22	12	35	...do	...do	...do	...do	...do	No.	Yes.		
22	13	35	...do	...do	...do	...do	...do	No.	Yes.		
22	14	35	...do	...do	...do	...do	...do	No.	Yes.		
22	15	35	...do	...do	...do	...do	...do	No.	No.		
Nov. 14	16	30	German	...do	...do	...do	Out to sea	No.	Yes.		
14	17	25	...do	...do	...do	...do	...do	No.	Yes.		
14	18	25	...do	...do	...do	...do	...do	No.	Yes.		
14	19	25	...do	...do	...do	...do	...do	No.	Yes.		
14	20	25	...do	...do	...do	...do	...do	No.	Yes.		
14	21	25	...do	...do	...do	...do	...do	No.	Yes.		
14	22	25	...do	...do	...do	...do	...do	No.	Yes.		
14	23	25	...do	...do	...do	...do	...do	No.	Yes.		
14	24	25	...do	...do	...do	...do	...do	No.	Yes.		
14	25	25	...do	...do	...do	...do	...do	No.	Yes.		
14	26	25	...do	...do	...do	...do	...do	No.	Yes.		
14	27	25	...do	...do	...do	...do	...do	No.	Yes.		
14	28	25	...do	...do	...do	...do	...do	No.	Yes.		
14	29	25	...do	...do	...do	...do	...do	No.	Yes.		
14	30	25	...do	...do	...do	...do	...do	No.	Yes.		
14	31	25	...do	...do	...do	...do	...do	No.	Yes.		
14	32	25	...do	...do	...do	...do	...do	No.	Yes.		
14	33	25	...do	...do	...do	...do	...do	No.	Yes.		
14	34	25	...do	...do	...do	...do	...do	No.	Yes.		
14	35	25	...do	...do	...do	...do	...do	No.	Yes.		
14	36	25	...do	...do	...do	...do	...do	No.	Yes.		
14	37	25	...do	...do	...do	...do	...do	No.	Yes.		
14	38	25	...do	...do	...do	...do	...do	No.	Yes.		
14	39	25	...do	...do	...do	...do	...do	No.	Yes.		
14	40	25	...do	...do	...do	...do	...do	No.	Yes.		
14	41	25	...do	...do	...do	...do	...do	No.	Yes.		
14	42	25	...do	...do	...do	...do	...do	No.	Yes.		
14	43	25	...do	...do	...do	...do	...do	No.	Yes.		
14	44	25	...do	...do	...do	...do	...do	No.	Yes.		
14	45	25	...do	...do	...do	...do	...do	No.	Yes.		



2.—SYNOPTICAL TRANSCRIPT OF NOTES FROM THE FIRING RECORD.

Russian life-saving rockets and stand.

Date.	No. of round.	
1879.		
Oct. 18	1	Italian hemp line No. 6. Line carried out 250 yards from firing point, when the rocket chain broke, freeing the rocket, which burst shortly afterwards. The fragments of the rocket and chain were found. The rear diaphragm, to which the rocket stick is attached, was found to have been blown out, the walls between the vents not being strong enough to withstand the pressure of the imprisoned gases. The ring of the rocket chain had a flaw in the material. The chain parted at that point. It is probable that the chain broke at the instant the composition took fire all around, giving a sudden increase of velocity.
18	2	Rocket exploded as before. Flight erratic; rocket ricocheted on the water before bursting.
18	3	Erratic trajectory. Rocket ricocheted on the water, turned to the right, *from* which direction the wind was blowing, and finally burst.
18	4	Struck the sand beach 60 yards from the stand, ricocheted and disappeared beneath the water.
20	5	Rocket exploded about 200 yards in front of stand. Used quick-match in the vents. Rocket shot out of tube almost the instant the port-fire was applied.
20	6	No remarks. By some mistake the record was left incomplete.
22	7	Exploded in the air. Time of flight, 4½ seconds.
22	8	Exploded in the air 2½ seconds from time of starting.
22	9	Exploded in the air 4 seconds from time of starting.
22	10	Exploded in the air about 280 yards from the stand; time lost.
22	11	Exploded in the air; no time taken.
22	12	Exploded in 1¾ seconds from time of starting.
22	13	Exploded in 2 seconds from time of starting.
22	14	Exploded in the air; no time taken.
22	15	Did not explode. Good line shot. Ricocheted two or three times on the sand.
Nov. 14	16	Exploded in the air.
14	17	Exploded in the air.
14	18	Exploded in the air.
14	19	Exploded in the air.
14	20	Exploded in the air.
14	21	Exploded in the air.
14	22	Exploded in the air.
14	23	Exploded in the air.
14	24	Exploded in the air.
14	25	Rocket exploded in the air.
14	26	Rocket exploded in the air.
14	27	Rocket exploded in the air.
14	28	Rocket exploded in the air.
14	29	Rocket exploded in the air.
14	30	Rocket exploded in the air.
14	31	Rocket exploded in the air.
14	32	Rocket exploded in the air.
14	33	Rocket exploded in the air.
14	34	Rocket exploded in the air.
14	35	Rocket exploded in the air.
14	36	Rocket exploded in the air.
14	37	Rocket exploded in the air.
14	38	Rocket exploded in the air.
14	39	Rocket exploded in the air.
14	40	Rocket exploded in the air.
14	41	Rocket exploded in the air.
14	42	Rocket exploded in the air.
14	43	Rocket exploded in the air.
14	44	Rocket exploded in the air.
14	45	Rocket exploded in the air.

PART III.

GERMAN LIFE-SAVING ROCKETS AND ROCKET APPARATUS.

GERMAN LIFE-SAVING APPARATUS.

I.—5^{cm} GERMAN LIFE-SAVING ROCKET.

(Plate III.)

1.—DESCRIPTION.

The 5-centimeter German life-saving rocket (5^{cm} Rettungsrakete) is composed essentially of a body, head, base, rocket-stick and chain. The rocket case or body is cylindrical, made of sheet metal 0″.05 in thickness.

The head is ogival, with a shoulder that extends one-fourth of an inch beyond the case, and has a cylindrical tenon to fit the front end of the rocket case.

The latter is secured to the head by screws. The inside of the rear end of the case is reinforced for 1″.1 of its length by a cylindrical metallic ring, which serves as a seat for the screws that attach the base to the body.

The base extends to the rear, forming three ribs, placed triangularly, with all the metal removed from the axial portion to facilitate the escape of gas. These ribs conjoin at their posterior ends. An axial hole is drilled through this portion, having a female screw thread cut upon its interior surface to receive the screw on the end of the rocket stick.

When prepared and packed for service the composition is covered by a water-proof cap, from which projects a fuse, extending 2″.5 towards the rear. The fuse is steadied in its position by a strap of laboratory paper reaching to one of the ribs. The fuse and cap are covered with a coat of shellac varnish. Care must be taken in handling not to break off the fuse, which is more or less exposed.

The rocket-stick is of wood, enveloped at the front end by a metallic frustum of a cone, whose larger base receives the end of the stick, and whose smaller base is penetrated by the shank of a screw, intended to enter the hole in the base of the rocket. The stick, frustum, and screw-shank are bound together, and held in place by two wrought-iron bolts of small diameter.

The rear end of the rocket-stick is armed with an iron loop, with flattened arms, slightly curved to fit the outside of the stick. This loop serves as the point of connection for the rocket-chain.

The diameter of the rocket-stick is slightly greater in the middle than at either end.

All the metallic parts of this line-carrying projectile are painted black.

2.—Principal dimensions and weights.

	Inches.	Centimeters.
Total length of 5cm life-saving rocket	23.5	59.69
Case or body:		
Length	15.0	38.10
Exterior diameter	2.15	5.45
Interior diameter	2.05	5.20
Thickness of metal	0.05	0.13
Head:		
Total length	5.2	13.20
Point—		
Length of	3.6	91.44
Diameter of base	2.65	6.73
Tenon—		
Length	1.6	4.06
Diameter	2.05	5.20
Base-ring:		
Length	1.1	2.79
Exterior diameter	2.05	5.20
Interior diameter	1.65	4.19
Base:		
Total length	5.8	14.73
Diameter, front end	2.65	6.73
Diameter, rear end	1.25	3.17
Length, embracing case	0.9	2.28
Length of female screw in rear end	1.2	3.05
Diameter of screw hole	0.625	1.57
Depth of ribs at front end	0.45	1.14
Depth of ribs at rear end	0.40	1.01
Width of ribs	0.35	0.89
Number of ribs	Three	.....
Rocket-stick:		
Total length	39.4	100.07
Diameter at junction with rocket	1.2	3.05
Diameter at larger base of frustum	2.2	5.58
Diameter at middle	2.2	5.58
Diameter at rear end	2.0	5.08
Rocket-chain:		
Total length	87.0	220.98
Ring—		
Exterior diameter	1.5	3.81
Interior diameter	0.7	1.78
Thickness	0.4	1.01
Links—		
Length	1.5	3.81
Width	0.75	1.90
Thickness	0.20	0.51
Total length of rocket and stick	61.7	156.71
	Pounds.	Kilos.
Weight of rocket	10.0	4.53
Weight of rocket stick and chain	5.5	2.49
Total weight of rocket complete	15.5	7.02

For further details, see Plate III.

II.—8cm GERMAN LIFE-SAVING ROCKET.

(Plate IV.)

1.—DESCRIPTION.

The form and construction of this life-saving rocket (8cm Rettungs-rakete) is essentially the same as the 5-centimeter rocket, from which it differs only in dimensions and weight. The description of the 5cm rocket will answer for this one.

2.—Principal dimensions and weights.

	Inches.	Centimeters.
Total length of 8cm life-saving rocket	34.5	87.63
Case or body:		
Length	10.5	26.67
Exterior diameter	3.22	8.17
Interior diameter	3.1	7.87
Thickness of metal	0.06	0.15
Head:		
Total length	8.75	22.21
Point—		
Length	7.25	18.40
Diameter of base	3.75	9.51
Tenon—		
Length	1.5	3.81
Diameter	3.1	7.87
Base-ring:		
Length	1.35	3.42
Exterior diameter	3.1	7.87
Interior diameter	2.875	7.29
Base:		
Total length	8.3	21.08
Diameter of front end	3.75	9.51
Diameter of rear end	1.50	3.81
Length, embracing case	1.8	4.57
Length of female screw in rear end	1.6	4.06
Diameter of screw-hole	0.625	1.58
Depth of ribs at front end	0.75	1.90
Depth of ribs at rear end	0.875	2.21
Width of ribs	0.75	1.90
Number of ribs	Three	.....
Rocket-stick:		
Total length	39.9	101.34
Diameter at junction with rocket	1.4	3.55
Diameter at larger base of frustum	2.0	5.08
Diameter at middle	2.3	5.84
Diameter at rear end	2.3	5.84
Rocket-chain:		
Total length	122.5	310.64
Ring—		
Exterior diameter	1.7	4.31
Interior diameter	1.1	2.79
Thickness	0.3	0.76
Links—		
Length	1.3	3.30
Width	0.6	1.52
Thickness	0.2	.50
Total length of rocket and stick	73.3	186.18
	Pounds.	Kilos.
Weight of rocket	35.0	15.98
Weight of rocket stick and chain	7.25	3.29
Total weight of rocket complete	42.25	19.27

For other details see Plate IV.

III.—8cm GERMAN ANCHOR ROCKET.

(Plate V.)

1.—DESCRIPTION.

The 8-centimeter anchor rocket (8cm Ankerrakete) for life-saving purposes is composed of a body, anchor-head, base, rocket stick and chain.

The case, or rocket-body, is made of sheet-metal, 0″.06 in thickness.

The anchor-head is made of iron. The front end is sub-spherical in form, connected with the convex curves of the arms by re-entrant tangent-curved surfaces.

The short shank in rear of the head forms a cylindrical tenon that fits the front end of the rocket case, to which it is secured by screws.

The arms and flukes are four in number. The former are triangular-prismoidal in outline, and are placed at right angles to each other.

The arms are furnished with the usual palmate flukes, which are well adapted for "holding."

The rear end of the rocket case is reinforced on the inside for 1″.5 of its length by a cylindrical iron ring. The latter furnishes a seat into which the screws that attach the base are turned.

The base is tripodal in form, the legs joining a cylindrical ring at the front end. The conjunction of the legs, or ribs, at the rear end forms a seat into which is screwed the rocket stick.

When prepared for use and ready for packing the rocket case is filled with composition and the rear end of the case closed with a water-proof cap to protect the contents from the effects of moisture.

This cap is placed 1″.3 towards the front from the rear edge of the basal ring. A fuse, 2″.7 in length and 0″.5 in diameter, passes through the cap and connects with the rocket composition.

The projecting fuse is liable to be broken off in handling, if great care is not exercised, as the operator will involuntarily thrust his hand between the ribs to grasp the rocket in picking it up or carrying it.

The fuse is steadied in its position by a strap of laboratory paper attached to one of the ribs in the same manner as in the 5cm rocket.

The fuse is coated with shellac varnish.

The rocket *stick*, technically so called, is in this case a hollow cylindrical tube of sheet metal, with a diameter about equal to that of the wooden stick for the 8cm life-saving rocket.

It is constructed by taking a strip of sheet metal of the necessary length and width, curving it and fastening the edges together with twenty-three iron rivets.

The front end is filled with an iron plug extended to the front as a frustum of a cone, 1″.125 in altitude, from which projects the male screw, 2″.25 long, that enters the base of the rocket when assembled for use. The rear end is furnished with an iron loop having flattened arms that are riveted to the tube. This loop serves as the point of attachment for the rocket-chain.

The rocket-chain is made of the best wrought iron.

The rocket case, base, and "stick" form the *shank* of the quadripalmate anchor.

The usual anchor *stock* is absent in this combination.

The anchor rocket, rocket-stick, and chain are all painted black.

2.—Principal dimensions and weights.

	Inches.	Centimeters.
Total length of 8cm anchor rocket	33.15	84.19
Rocket-case:		
Length	20.15	51.17
Exterior diameter	3.22	8.17
Interior diameter	3.1	7.87
Thickness of metal	0.06	0.15
Anchor-head:		
Total length	6.5	16.51
Diameter, excluding arms	3.35	8.50
Length of tenon-shank	1.85	4.69
Diameter of tenon-shank	3.1	7.87
Arms—		
Depth near shank	1.4	3.55
Width under side near shank	1.2	3.04
Depth near fluke	0.8	2.03
Width under side near fluke	0.8	2.03
Number of	Four	
Distance from front end of head to rear edge of arm*	4.65	11.80
Distance from front end of head to point of fluke*	7.55	19.17
Spread of flukes	15.5	39.36
Length of palms	3.75	9.51
Width of palms	3.75	9.51
Base-ring:		
Length	1.5	3.81
Exterior diameter	3.1	7.87
Interior diameter	2.87	7.28
Base:		
Total length	9.4	23.87
Diameter, front end	3.75	9.51
Diameter, rear end	1.8	4.57
Length of, embracing case	1.4	3.55
Length of female-screw thread	2.0	5.08
Diameter of same	0.875	2.21
Depth of ribs, front end	6.75	1.90
Depth of ribs, rear end	0.80	2.03
Width of ribs	0.40	1.01
Number of ribs	Three	
Rocket-stick:		
Total length	39.375	99.98
Length of screw	2.25	5.71
Diameter of screw	0.875	2.21
Number of rivets	23.0	58.41
Rocket-chain:		
Total length	123.0	312.41
Ring—		
Exterior diameter	1.5	3.81
Interior diameter	0.7	1.77
Thickness	0.4	1.01
Links—		
Length	1.5	3.81
Width	0.75	1.90
Thickness	0.20	0.50
Total length of rocket and stick	70.275	178.47
	Pounds.	Kilos.
Average weight of anchor rocket	37.375	16.95
Average weight of rocket stick and chain	9.0	4.08
Total weight of anchor rocket complete	46.375	21.03

*Measured parallel to the axis of the rocket.

See Plate V for other dimensions.

IV.—GERMAN LIFE-SAVING ROCKET-STAND.

(Plate VI.)

1.—DESCRIPTION.

The German rocket-stand is trough-like in shape, and is supported by two legs near the front end and a curved iron foot or tang at the rear end.

The general outline may be seen by reference to the plate, Figs. 1 to 6.

The trough-like body of the tube is made of sheet iron or steel, and is constructed from a single piece of metal, curved over a former of the required shape.

A longitudinal slot in the bottom, I0″.9 long and 1″ wide, extends from the front end to the first exterior rib (Fig. 2). This slot is for the reception of the rocket-chain, which is led along the bottom of the trough under the rocket and stick, and allowed to pass downward through this slot.

The longitudinal edges of the trough are stiffened and strengthened by angle-pieces of iron running the whole length. These angle-pieces have one side riveted to the inside of the trough, forming the bearing surfaces for the rockets, and the other forming an exterior projecting flange.

A rolled iron bar, 1″ wide and 0″.3 thick, runs from the rear end of the longitudinal slot the whole length of the trough on the under side.

The lower or rear end of this metallic bar projects about 10″. beyond the frame, is decurved and pointed, to form the claw or tang for the support of this end of the trough.

A curved brass plate, 0″.7 wide and 0″.3 thick, arches over the rear end of the frame, forming an abutting surface for the rocket-stick and binding the sides of the trough together.

Two six-inch braces, 0″.7 wide, extend backwards and downwards to the tang from the junctions of the brass plate with the sides of the trough.

The angle-pieces, bottom bar, brass plate, and braces give strength and rigidity to the rocket-stand.

The stand is further strengthened by four nearly equi-distant exterior iron ribs, 1″ wide, that serve to bind the component parts together.

On the under side, below the first rib, is a lug which supports a horizontal axis.

The ends of this axis are slotted to receive the ends of the legs. The latter are held in position by metallic pins passing through their blade-like ends and the axis.

These projections from the legs are trapezoidal, the beveled ends abutting against side plates on the exterior of the trough when the stand is in use.

The side plates prevent the indentation of the thin metal of the trough by the upper ends of the legs.

The legs are of wood, ferruled with iron at each extremity to prevent splitting.

Decurved iron spikes in the lower ends enable them to be placed firmly in the hard or frozen soil to give stability to the stand.

The legs can be closed together and then folded to the rear until they lie parallel to the axis of the trough.

Notwithstanding the angle-irons, the longitudinal slot at the front end weakens the trough considerably; to remedy this, side plates, 10″.6 long, are placed one on each side under the forward rib to stiffen the sides.

The draughtsman has erred slightly in outlining the cross-section of the trough in Plate VI. As shown there it is nearly semi-circular in form, while it should have appeared almost trapezoidal with a rounded bottom.

The planes of the projecting flanges are represented as being coincident, whereas they should bend downwards slightly, forming an obtuse angle with each other. This rocket-stand is painted a lead-color.

2.—*Principal dimensions and weight.*

	Inches.	Centimeters.
Trough:		
Total length	72.75	184.78
Total length with rear tang	82.75	210.18
Interior width at top	3.8	9.65
Interior width at bottom	1.0	2.54
Inside slant height of sides	2.8	7.11
Length of slot at front end	10.9	27.68
Width of slot at front end	1.0	2.54
Exterior ribs—		
Number of	Four.	
Width	1.0	2.54
Distance of horizontal axis from front end	15.5	39.36
Two legs:		
Total length	54.375	138.10
Diameter of upper end	1.3	3.30
Diameter of lower end	1.3	3.30
Length of spike in lower end	3.0	7.62
	Pounds.	Kilos.
Weight of rocket-stand	35.0	15.98

For further particulars consult the drawings, Plate VI.

V.—FIRING-STAFF.

(Plate VI, Fig. 7.)

1.—DESCRIPTION.

This is made of wood, shod at one end with a sharp-pointed steel socket and armed at the other with a hollow brass tube, bent and split to form a hinged clamp. The latter is actuated by a lever and spring.

This staff is used to hold the *pillenlichte* for igniting the rocket fuse.

The sharp-pointed socket is for convenience in thrusting it into the ground in an upright position.

If carelessly thrown aside, it is liable to be lost in the sand. The staff is painted the same color as the rocket stand.

The drawing shows a *pillenlicht in situ.*

2.—*Dimensions and weight.*

	Inches.	Centimeters.
Total length	72.0	182.88
Diameter	1.2	3.04
Length of pointed socket	10.0	25.40
	Pounds.	Kilograms.
Weight	2	0.91

VI.—FIRING-LOCK.

(Plate VII, Figs. 1–4.)

1.—DESCRIPTION.

The firing-lock, or more properly the igniting-lock (Zündschloss), is an instrument used for the purpose of igniting the primer in the end of the *pillenlicht* by percussion.

The principal components are the stock, lock tube, firing-bolt, bolt-spring, bolt-pin, firing-pin, firing-lever, and spring.

2.—STOCK.

The stock is made of hard wood, neatly finished. The lock-tube is attached to the front end of the stock, on the under side of which is a curved projection to give a firm grip to the hand of the operator.

A hole is sometimes bored through the butt of the stock, through which a cord is passed for the purpose of attaching it to the belt of the surfman or to his wrist in order to prevent its loss.

3.— LOCK-TUBE.

This is made of bronze (gun metal), carefully turned and finished upon the exterior. The middle portion of the tube is cylindrical, expanding at the front end.

The rear portion is also cylindrical, greater in diameter than the middle part, to which it is joined by a projecting molding. This molding is slotted longitudinally on top to form a fulcrum seat for the firing lever.

The front end is countersunk to form a cavity whose interior surface is somewhat bell-mouthed in shape.

An axial hole is bored from the rear end nearly to the anterior cavity, and a small hole for the firing-pin is drilled through to connect the two. The large hole is counterbored to within 0″.8 of the bottom in order to increase its diameter for the reception of the body of the firing-bolt and its spiral spring.

A transverse slot, with circular ends, extends through the tube from side to side to allow longitudinal play for the bolt-pin in cocking and firing.

On top of the tube, directly over the middle point of the transverse slot, is a square mortise through which the bolt-catch on the firing-lever passes.

A hole is drilled in the upper part of the molding for the fulcrum-pin of the firing-lever, and another near the rear end for the assembling-pin that holds the tube and stock together.

4.—FIRING-BOLT.

The firing-bolt is cylindrical, with a round tenon in front of the body. The tenon fits closely the hole in the tube below the counterbore, and is armed at its front end with a needle or firing-pin.

A transverse hole through the body receives the bolt-pin of steel wire which projects on each side of the tube.

The bolt is actuated by a spiral spring of steel wire. The spring is placed between the bolt-head and a plug that fills the rear portion of the axial hole.

The firing-pin or needle is made of steel wire driven into a hole in the front end of the bolt and then brought to a very sharp point.

5.—FIRING-LEVER.

The firing-lever is made of steel and tempered. The rear end is flattened and bent slightly upwards to serve as a trigger.

At the front end is a rectangular bolt-catch projecting at right angles from the under side of the lever.

A flat steel spring under the rear end of the lever presses that end upwards and holds the bolt-catch down on the bolt. This catch passes through the mortise in the tube.

6.—*Principal dimensions and weight.*

	Inches.	Centimeters.
Total length of firing-lock	9.4	23.87
Length of lock-tube	5.75	14.59
	Ounces.	Grams.
Weight of firing-lock	11.25	318.93

7.—ACTION.

Seize the stock in the right hand, and with the thumb and index finger of the left compress the spiral bolt-spring by pulling the transverse bolt-pin A (Plate VII) to the rear until the bolt-catch I drops off the body of the bolt B, and falls upon the tenon C.

The spring S will press up the rear end of the firing-lever T and keep the bolt-catch in place.

The annular shoulder of the bolt presses against the rear surface of the catch. In this position the firing-pin D, or needle, is withdrawn into the lock-tube, as shown in Fig. 3. The pressure of the thumb of the right hand upon the flattened end T (Fig. 2) of the lever compresses the spring S (Fig. 3), elevates the bolt-catch I (Fig. 3), to the position I (Fig. 4), releases the bolt, and allows the spiral spring F (Fig. 3) to act.

The bolt springs forward, thrusting the firing-pin D out into the cavity E, where it strikes the fulminate in the end of the *pillenlicht* P and ignites the composition.

8.—USE.

The object of the firing-lock is to furnish a ready means of igniting *pillenlichte* after they are inserted in the firing-staff and clamped.

VII.—PILLENLICHTE.

(Plate VII, Fig. 5.)

1.—DESCRIPTION.

These are short cylindrical tubes of laboratory paper, filled with a composition resembling that in port-fires. The exact ingredients and and their proportions are unknown.

A countersink is formed in one end, at the bottom of which is placed a small disk of fulminate covered with a water-proof cap. The entire exterior is varnished.

A section of a *pillenlicht* is shown at P (Fig. 4, Plate VII). These are used to light the fuses of the life-saving and anchor rockets.

The *pillenlichte* are put up in packages of twenty (20) each.

2.—*Dimensions and weight.*

	Inches.	Centimeters.
Total length	1.55	3.93
Exterior diameter	0.625	1.58
Depth of countersink in end	0.1	0.25
	Seconds.	
Time of burning	45	.....
	Grains.	
Weight	230	.....

VIII.—PACKING.

LIFE-SAVING ROCKETS.

1.—DESCRIPTION.

The German anchor and life-saving rockets are packed securely in tin-lined boxes. The boxes are made of hard pine, planed smooth on both sides, with the corners dovetailed. The bottom, sides, and ends are lined with tin. The top is not lined and is screwed to the sides and ends. A label on the inside of the cover of the box bears printed on its face a list of the contents of the box in the German language. A similar label is pasted on the end of the box. The rocket boxes are oiled but not painted. Bottom, middle, and top clamps at each end hold the rockets in place. A strip of felt separates the rockets from the clamps.

2.—DIMENSIONS OF PACKING-BOXES.

a.—For 5cm life-saving rockets.

	Inches.	Centimeters.
Exterior dimensions: Length	26.75	67.93
Exterior dimensions: Width	9.5	24.13
Exterior dimensions: Depth	8.125	20.57
Number of rockets in each box		Four.

b.—For 8cm life-saving rockets.

	Inches.	Centimeters.
Exterior dimensions: Length	37.25	94.10
Exterior dimensions: Width	12.5	31.74
Exterior dimensions: Depth	11.25	28.56
Number of rockets in each box		Four.

c.—For 8cm anchor-rockets.

	Inches.	Centimeters.
Exterior dimensions: Length	36.0	91.44
Exterior dimensions: Width	14.25	36.18
Exterior dimensions: Depth	20.5	52.06
Number of anchor-rockets in each box		Two.

3.—WEIGHTS.

	Pounds.	Kilogrammes.
Total weight of packing-box containing four 5cm rockets	61.5	27.88
Total weight of packing-box containing four 8cm rockets	195.5	88.67
Total weight of packing-box containing two 8cm anchor-rockets	151.0	68.49

4.—ROCKET-STANDS.

The German rocket stands are packed in long narrow boxes, painted a lead color. The top is screwed to the sides and ends. Rope loops,

two on each side near the ends serve as handles for transportation. A firing-staff is placed in each box.

a.—Dimensions and weight.

	Inches.	Centimeters.
Exterior dimensions.. Length	86.0	218.44
Width	8.0	20.32
Depth	7.25	18.40
	Pounds.	Kilos.
Total weight of box with stand and staff	81.5	36.90

5.—ROCKET STICKS AND CHAINS.

1.—DESCRIPTION.

The sticks and chains for the 5-centimeter and 8-centimeter rockets are tied in bundles of 4 each.

The chains are doubled back and forth the length of the stick, and have the loops fastened to the ends of the stick by twine.

The anchor-rocket sticks are placed in bundles of two each.

2.—WEIGHTS OF BUNDLES.

	Pounds.	Kilogrammes
For 5cm rockets, 4 sticks and chains	22.25	10.08
For 8cm rockets, 4 sticks and chains	29.0	13.15
For 8cm anchor-rockets, 2 sticks and chains	18.0	8.16

IX.—DATE OF MANUFACTURE.

All the German life-saving rockets, 5-centimeter, 8-centimeter, and 8-centimeter anchor-rockets were fabricated in 1877. The rockets were packed in December, 1877, as shown by the labels.

X.—GERMAN ROCKET-LINE.

This rocket line is made of hemp. The line is twisted, and is made with three strands, each composed of four yarns. The diameter of this line is 0″.31, or a little greater than "No. 9 Silver Lake braided cord." The rocket-line is stowed in the faking-box in the usual manner. The combined weight of the faking box and line is 100 pounds, or 9.5 pounds greater than the United States service box A, with a No. 9 linen line.

XI.—GERMAN FAKING-BOX.

(Plate VIII.)

1.—DESCRIPTION.

These boxes contain the rocket-lines, and are similar to those in use in our own service. They differ from the American box in being longer, a little less in width, and far more complicated in construction.

The top has three equidistant transverse cleats on the upper side to strengthen it. A lip at each end overhangs the end of the box. Iron straps attached to the lid and run inside of the box form the hinges. These hinges are held in position and swing upon iron pins 5″.875 in length, having an eye at one end and a slot at the other. A leather thong is made fast in the eye-hole, and is long enough to pass through the slot in the other end of the pin. This pin is thrust through the cylindrical heads of the hinge straps on the box and lid, and the thong is passed through the slot to secure the pin in position. This arrangement admits of the top or lid being removed entirely when desired. Two slotted straps or hasps attached to the front side of the lid engages the staples on the front of the box. The body of the box is rectangular in shape, open at the top and bottom, and of sufficient depth to contain the faking-pins and line.

The staples on the front side of the box are seated upon iron plates 2″ × 1″.5. The plates are let into the wood a distance equal to their thickness, and are held in place by four short screws, one at each angle or corner. The handles are placed at the ends of the box near the upper edge. These are of one-fourth inch iron wire, bent to the required form, and passed through staples attached to thin iron plates 4″.5 × 2″.125 screwed to the box. Near the lower edges of the ends, midway between the sides, are two plates carrying the iron hooks that engage corresponding staples on the frame and attach the box to the frame.

The frame is made of 1″.25 lumber, and is 46″.5 in length by 17″.375 in width. The width of the side and end pieces is 4″.5. Holes are bored and tapped to fit the screw-thread tenons of the faking-pins in both the side and end pieces. There are sixteen pins on each side and four at each end—forty in all. The false bottom is pierced with holes corresponding to the number of faking-pins, and is placed over them, resting upon the frame.

The corners of the body of the box are covered with sheet-iron angle-pieces. The corners of the lid are similarly protected.

The total weight of the faking-box and rocket-line is 100 pounds. The faking-box is made of hard pine, and painted lead color.

For further details and dimensions, see Plate VIII.

XII.—Method of using the German rocket apparatus.

The apparatus is supposed to be at the firing-point. First remove the rocket-stand from its box, spread the legs, and place the stand with the axis of the trough pointing in the desired direction. Then give the proper elevation by raising or lowering the front end by means of the legs.

A quadrant or combination level is used to adjust the elevation. Place the faking-box several feet in front of the stand, turn it upside down, remove the frame and pins and false bottom. Incline the box to the front with its length in the direction of the line of fire, and place the false bottom or frame transversely on edge beneath the rear end of the box, to preserve the proper inclination towards the front. Then screw a rocket-stick into the base of one of the rockets, put the chain in the slot at the front end of the trough of the stand, and lead it along the bottom of the trough. Place the rocket in the trough over the chain, drawing the latter taut, and allow the end of the stick to abut against the plate at the lower end of the trough; carry the other end of the rocket-chain to the front and tie the rocket-line to the ring. The rocket is now ready to be fired.

Take a *pillenlicht* and put the square end in the clamp of the firing-staff, which brings the end with the fulminating primer to the front. Next place the bell-shaped mouth of the firing-lock, with the firing-pin withdrawn, over the outer end of the *pillenlicht;* press the thumb upon the rear end of the firing-lever. This action relieves the firing-pin, the spiral spring throws it to the front, exploding the primer, which sets the composition on fire. Approach the rocket-stand, extend the firing-staff until the burning *pillenlicht* comes in contact with and ignites the fuse in the base of the rocket. After seeing that the fuse is properly ignited, stand clear of the apparatus.

XIII.—ACTION.

As soon as the fuse burns up to the base of the rocket, the composition takes fire, and the rocket, guided by the inclined trough of the stand, is launched to the front, carrying with it the stick, chain, and rocket-line. The object of the stick is to give steadiness to the flight, that of the chain to preserve the line from being burned off by the flames issuing from the rocket.

XIV.—*Cost of German life-saving apparatus* (1875).

Articles.	Cost.	
	German reichs-marks.	United States dollars.
Life-saving rocket (8 centimeter) carrying line 1,400 feet	24.20	5.808
Life-saving rocket (5 centimeter?) carrying line 1,000 feet	15.00	3.60
Anchor-rocket, 1,400 feet	101.00	24.24
One shot-line, 1,600 to 1,700 feet long (extra made)	60.00	14.40
	70.00	16.80
Double hauling-line	113.00	27.12
Large hawser, 1,000 feet long	216.00	51.84
Tongs or nippers for holding cartridge	6.00	1.44
Pistol for firing cartridge (firing-lock)	6.66	1.5984
	7.50	1.80
Quadrant	9.90	2.376
Iron support (or tripod) for rockets	40.00	9.60
Box for shot-line (each)	36.00	8.64

The whole rocket apparatus, placed upon one wagon, with all necessary appurtenances except rockets, costs 4,400 marks = $1,056. Complete double wagon, with appurtenances, costs 3,730 marks = $895.20.

There are three reserve faking-boxes for each rocket apparatus.

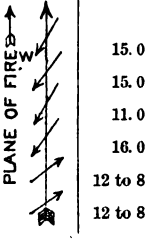
(N. B.—One German reichsmark = 24 cents, gold.)

XV.—Experiments with German life-saving rockets.

Experiments with life-saving apparatus at Sandy Hook, New Jersey.

1.—*Record of firings with German life-saving and anchor rockets and apparatus.*

Date.	Number of fire.	Elevation.	Kind of rocket-stand.	Life-saving rocket.				With what fired.	Shot-line.				Range.	Deviation of rocket, right or left.	Drift of shot-line at 300-yard stake.	Wind.	
				Caliber, centimeters.	Kind.	Weight.	Total weight, rocket, stick, and chain.		Material.	Number of line.	Length.	Action.				Direction.	Velocity, miles per hour.
1879.		°				*Lbs.*	*Lbs.*				*Yds.*		*Yards.*	*Feet.*	*Feet.*		
Oct. 18	1	32.5	German...	5	German...	10	15.5	Port-fire, Eng.	Dark linen....	4	700	Good	404	87 R.	56 R.		15.0
18	2	31	....do	5	....do	10	15.5	....do	Linen, W. P...	4½	700	....do	402⅓	103 L.	99 L.		15.0
18	3	31	....do	8	....do	35	42.25	....do	....do	6	600	Broken	.....	Left.	Left.		11.0
18	4	31	....do	8	....do	35	42.25	....do	....do	6	600	Good	545⅔	103 L.	88 L.		16.0
20	5	31.5	....do	8	Anchor ...	37	46	Pillenlicht....	Italian hemp..	9	600	Tangled and cut.	.....	.....	.....		12 to 8
20	6	31	....do	8	....do	37.75	46.75	....do	Linen.....	10	600	Good.....	350 to 400	Estimated.	.....		12 to 8



NOTE.—The shot-lines used were the Silver Lake Company's braided lines.
Abbreviations: R = right; L = left; W. P. = water-proof.

2.—SYNOPTICAL TRANSCRIPT OF NOTES FROM THE FIRING-RECORD.

German life-saving and anchor-rockets and stand.

Date.	No. of round.	
1879.		
Oct. 18	1	Service faking-box used and placed 2 feet to right of stand, and to the rear nearly the length of the rocket-chain. Action of rocket, good.
18	2	Same remark. A larger line used.
18	3	8cm rocket. Line broke. It is quite probable that the line in vibrating struck a sharp corner on the stand and was cut off, as the faking-box was placed to the right and rear as in the preceding shots. An examination of the frayed ends of the line gave no definite solution of the manner of severance. Spent rocket recovered about 900 yards from the firing point.
18	4	8cm rocket. Used same line as before. Action of rocket, good.
20	5	8cm anchor-rocket. Fired out to sea. No. 9 line in loose coils as wound up around hand and elbow. Coils got caught and were carried out to sea in large bunches. The line was cut by drawing through a tangled knot. Range about 250 to 300 yards, estimated—a low estimate. Range much diminished by increased resistance of air due to the large "bunches" in the line.
20	6	8cm anchor-rocket. Fired out to sea. Used No. 10 linen line (Silver Lake), which was fired from the original coil. The line ran out well. In hauling in on the line it was estimated that the anchor slipped about 60 feet before it caught in the bottom and held. Life-boat of Station No. 1, District 4, New Jersey, was launched and hauled out to the anchor by the rocket-line. The anchor-rocket was hoisted into the boat and the latter hauled nearly to the shore by the line. The sea-water left the line stiff and difficult to handle; it could not be coiled easily.

NOTE.—In the German method of using the apparatus the rocket-chain is laid along the bottom of the trough of the stand under the rocket, and then, falling downward, is lead to the front, where the faking-box and line are placed. In the above trials the box was placed to the rear and a little to one side, to see whether the stand interfered with the running out of the line. In this instance the chain had to be led to the rear.

PART IV.

ENGLISH LIFE-SAVING ROCKET APPARATUS.

ENGLISH LIFE-SAVING APPARATUS.

I.—ENGLISH LIFE-SAVING ROCKET.

(Plate IX.)

1.—DESCRIPTION.

The 12-pounder rocket used by the English coast-guard service is the invention of Colonel (since General) Boxer, R. A. Three different patterns of these rockets have been made and issued. The one now in use is known as "Mark III."

The Boxer rocket is composed of a head, head-clip, body, base-clip, base-plug, and diaphragm.

The head is hemispherical in form, with a cylindrical tenon that fits in the front end of the rocket-case.

The head-clip nearly envelops the front end of the rocket-case, with its forward edge coincident with the exterior junction of the case and head. On one side of the case the iron strap forming the head-clip is bent outwards to form a short rectangular tube, whose axis is parallel to that of the rocket.

This short tube receives the front end of the rocket-stick.

The body of this rocket consists of two cylinders of sheet metal (Bes-

semer). These cylinders are placed end to end with their axes coincident with the same straight line. The front cylinder is shorter than the other, to which and the inner diaphragm it is joined by screws passing through cases into the diaphragm.

The front cylinder is filled with rocket composition to within 0″.4 of its front end. A conical-shaped cavity is left in the axial portion to furnish a large surface of inflammation.

The rear cylinder is filled in a similar manner with composition, leaving a solid portion of this composition at the front end between the two cavities 1″.2 in thickness. The cavity or "bore" of the rear cylinder is also conical in shape. The base-clip is analogous to that at the head, but is longer. It nearly surrounds the rear end of the rocket and has a rectangular tubular projection on one side in line with that of the head-clip. The base-plug closes the rear end of the cylinder and is pierced with an axial vent one inch in diameter, through which the gas escapes after the ignition of the composition.

The diaphragm is placed between and inside of the two body cylinders and performs the same functions for the front cylinder that the base plug does for the rear one, and in addition serves as a seat for the assembling-screws. A paper cap covers the vent, which must be broken before firing.

The rocket-cases are protected on the inside from the action of the composition by a coat of anti-corrosive paint; the outside is protected and blackened by burning off oil. Since 1870 the exterior of the case is still further protected by two coats of red paint.

2.—Dimensions and weight.

Boxer rocket.

			Inches.	Centimeters.
Total length			25.0	63.50
Radius of head			1.5	3.81
Diameter of rocket case	Exterior		2.75	6.98
	Interior		2.6	6.6
Length of front cylinder			9.3	23.62
Length of rear cylinder			14.2	36.06
Head-clip	Length		1.5	3.81
	Rectangular projection	Width	1.3	3.30
		Depth	1.2	3.05
Base-clip	Length		2.5	6.35
	Rectangular projection	Width	1.5	3.81
		Depth	1.3	3.30
Length of clip-pin			*0.85	2.15
Diameter of vent			1.0	2.54
			Pounds.	Kilograms.
Weight of rocket			14.25	= 6.46

* Length of clip-pin before bending, 1″.2. Size of wire, No. 8 Birmington wire-gauge.

II.—Packing.

The Boxer rockets are packed in rough lumber boxes containing six rockets each. The boxes are not painted.

III.—Date of manufacture.

The rockets presented for trial were made in 1877 and had the stamp of the Royal laboratory at Woolwich on the packing-boxes.

IV.—PAINTS.*

Red for outside of case of Boxer life-saving rocket.

	Pounds.	Ounces.
Lead, red	3	0
Lead, white	1	0
Litharge	0	4
Copperas	0	2
Oil, linseed, boiled	1 pint.	

Anti-corrosive paint for inside of Boxer life-saving rocket cases.

Copal varnish, pints	0.25
Gold size, pints	1.0
Turpentine, spirits, pints	1.25
Lead, white, dry, pounds	7.0

V.—ROCKET-STICKS.

(Plate IX, Fig. 5.)

1.—DESCRIPTION.

These are made of pine and are 9 feet 6 inches in length. The portion of the stick that extends through the clips along one side of the rocket is square in cross-section with a groove on the side next to the rocket to fit the curvature of the case. The stick in rear of the rocket is octagonal in cross-section. The lower end of the stick is surrounded by an iron ferrule.

Two plates are placed, one at the upper end of the stick and the other at a distance from that end equal to the distance between the clips on the rocket. The lower plate has a small flange that brings up against the lower clip when the stick is inserted in position for firing; both plates are hollowed to fit the rocket-case.

An iron clip-pin with the head bent at right angles is inserted in a hole through the stick in front of the base-clip, to prevent the withdrawal of the stick in firing.

The stick is partially surrounded for 18″ below the vent by a sheathing of tin to protect it from the burning gases.

Axial holes are bored in each end of the stick for the attachment of the line. These holes are curved outward from the axis until they reach the exterior of the stick on the same side. The holes are smoothed by passing a red-hot iron through them, charring the wood. The sticks are unpainted, and are packed in bundles of six (6) each.

2.—DIMENSIONS AND WEIGHTS.

	Inches.	Centimeters.
Length (9′ 6″)	114.0	289.55
Width	1.25	3.17
Thickness	1.25	3.17
Number in a bundle	Six.	
	Pounds.	Kilos.
Average weight of stick	3.16+	1.43
Average weight of each bundle	19 to 19.5	=8.61 to 8.73

* These were obtained from "Treatise on Ammunition, 1874," by Maj. W. R. Barlow, R. A., p. 298.

VI.—WASHERS.

Two kinds of washers are furnished with the Boxer rockets, brass and vulcanized India rubber. In firing, these are placed between the knot on the end of the rocket-line and the front end of the stick. The object of the washers is "to reduce the effect of the sudden jerk which is given to the line when the rocket is fired."

1.—DIMENSIONS.

		Inches.	Centimeters.
a. Brass washer	Diameter	1.0	2.54
	Thickness	0.15	0.38
	Diameter of hole in center	0.5	1.27
b. Rubber washer	Diameter	1.0	2.54
	Thickness	0.7	1.78
	Diameter of hole in center	0.5	1.27

VII.—ENGLISH LIFE-SAVING ROCKET-STAND.

(Plate X.)

1.—DESCRIPTION.

This stand is known as the Boxer rocket machine or stand, "Mark IV." The material is sheet-iron, except the legs, which are of wood. This stand is lighter and simpler in construction than the older forms.

The principal parts are an open rectangular trough or body, a curved trough, called by the English "a pry-pole," a horizontal axis, two legs, and a graduated arc made of brass.

The rectangular trough or body receives the rocket. Its width is less than its depth. The front end is stiffened by a narrow iron strap around the outside. The upper edges are rolled over wire for the same purpose. Near the rear end, on each side, are cut subelliptical holes to admit the port-fire in firing the rocket.

The body and pry-pole are connected by pieces of wrought iron, rivets, and braces. There are two of the latter, one on each side. Two pieces of wrought iron project from the rear end of the rectangular trough and have holes bored to receive the horizontal transverse axis.

The long rounded trough or pry-pole extends into the rear end of the body for a short distance. The upper edges of the pry-pole are rolled over a large wire to stiffen them, and the trough is still further strengthened by a wrought-iron bar 0″.5 thick, running along the bottom the whole length.

The lower or rear end of this bar is decurved and pointed to form a ground spike or foot. A strap with a buckle on the end is riveted to the pry-pole near the rear end, for the purpose of binding the legs to the pry-pole when they are folded up for transportation.

The horizontal axis has a small swinging tablet below, through which are pierced two holes for rivets for the legs. The latter have a lateral motion upon these rivets as axes.

The legs are made of tough wood. They have wrought-iron heads or sockets with slotted projections to embrace the tablet pendant from the horizontal axis. Ferrules envelop the lower ends, which are armed

with pointed spikes in order to secure a firm hold in the soil when placed in position.

On the right-hand side of the body, between the opening and the front end, is placed a sheet-brass quadrant (Fig. 2), graduated and marked from 0° to 35°. The limits of elevation that can be obtained with this stand, due to its construction, are from 17°.5 to 40°. At the center of this arc is a rivet with a projecting head, around which is fastened a short string with a minute pear-shaped plumb-bob dependent.

On the left-hand side of the body trough and parallel to its axis are the words "Life-Saving Apparatus," painted in white letters.

On the projection for the horizontal axis on the same side are painted the characters "IV," that designate the model of the stand.

Near the head of one of the legs is the date of fabrication, "1873."

The whole stand is painted lead color.

The rocket-stand is packed for transportation in a long, narrow box, made of rough lumber.

The contents of the box are marked upon the exterior.

2.—DIMENSIONS AND WEIGHTS.

			Inches.	Centimeters.
Total length of stand			116.0	294.63
Body	Length		27.75	70.45
	Width	Exterior	3.5	8.89
		Interior	3.	7.62
	Depth	Exterior	4.	10.16
		Interior	3.875	9.82
	Length of rear projections		1.7	4.32
	Size of openings in sides	Length	4.4	11.17
		Width	2.4	6.09
	Distance of front end of opening from rear end		7.25	18.41
	Distance from lower edge of opening to bottom		0.8	4.57
	Distance pry-pole inserted from rear end		7.25	18.41
	Distance between bottom of pry pole and bottom of body		2.7	6.86
Pry-pole	Length		95.5	241.42
	Interior width		1.5	3.81
	Depth	Exterior	2.	5.08
		Greatest interior	1.5	3.81
	Length of chord of ground-spike		3.0	7.62
	Distance of strap and buckle from rear end		46.0	116.84
Axis and tablet	Length		3.5	8.89
	Depth		2.6	6.6
Legs	Total length		61.125	155.24
	Length of slotted projection		2.0	5.08
	Diameter of socket	Upper end	1.0	2.54
		Lower end	1.4	3.55
	Ferrule	Diameter	1.4	3.55
		Length	1.5	3.81
	Length of spike		3.125	7.92
Packing-box	Length		121.0	307.33
	Width		6.0	15.24
	Depth		6.5	16.51
			Pounds.	Kilograms.
Weight of English rocket-stand			30.0	13.6
Weight of English rocket-stand and packing-box			73.5	33.34

VIII.—ROCKET-FUSE.

The life-saving rocket fuse is a frustum of a cone in shape, made of paper and covered with kamptulicon. It is 1″.5 long and fits the vent in the base of the rocket, which is 1″.0 in diameter. The fuse is covered with a paper cap tied on with twine.

The bore of the fuse is filled with about an inch of ordinary fuse-composition and burns about five seconds. The paper cap may or may not be removed before firing. The fuse is ignited by means of a port-fire.

IX.—PORT-FIRE.

The Boxer port fire for life-saving apparatus has a total length of 9″.3, and is cylindrical in form. The exterior diameter of the case is 0″.7. One end is closed with a tin cap and a piece of kamptulicon; this cap is 0″.5 long and 0″.8 in exterior diameter.

On one side the tin band of the cap is perforated to admit a detonating primer that enters a small space under the kamptulicon, and fires the priming of mealed powder. The exterior surface of the port-fire is painted flesh color. A circular black spot on the cap indicates the position of the hole for the detonating primer. The time of burning of this port-fire is six minutes.

1.—PACKING PORT-FIRES.

The port-fires are packed in tin cylinders, containing 25 port-fires each. These cylinders are 9″.6 in length and 4″.5 in diameter. A paper cylinder lines the inside of the tin one.

A paper cap pasted on the upper end of the port-fire cylinder bears the following printed upon it: "25 Port-fires, Life-Saving Apparatus, Mark I. Not to be opened until required for use or special inspection." This is followed by the date, government mark, and place of manufacture, thus:

"8 | 9 | 77"
"R ↑ L"

2.—A label pasted upon the cylindrical surface has the following legend printed upon it:

"*To open the cylinder.*—Take hold of the overlapping unsoldered end of the tin band, and tear off the band by a sharp pull or jerk. The pull must be from left to right, with the bottom of the cylinder against the body."

X.—ROCKET-LINE.

The English rocket-line is a loosely twisted Italian hemp line. No lines were sent with the apparatus received at Sandy Hook.

XI.—FAKING-BOX.

The faking-box used in the English service does not differ materially from our own. In fact our service-box was modeled after the English box. None of the latter accompanied the apparatus.

XII.—WRECK-LIGHT.

1.—DESCRIPTION.

This light is used for illuminating the beach at night in the vicinity of a wreck. It is hung upon a tripod and burns from 24 to 30 minutes. The tripod is a simple affair, consisting of three wooden legs, 6′ 4″ in length, weighing 12.5 pounds. The legs are connected at the top by an iron wire with a hook attached for suspending the light by a wire loop at its upper extremity. Three iron rods hooked to two of the legs form an inclined rest for the light, so that it may "hang in a sloping direction—not vertically downward."

The case is made of six cylindrical lengths of about 4″.5 each, fitted

end to end, and held by small tin bands half an inch in width. The joints are soldered. The case is filled with composition, and has the lower end primed with mealed powder and covered with kit plaster.

The method of hanging enables the light to clear itself of dross when burning. The heat of the burning composition successively melts the solder that holds the segments together, allowing the empty ones to fall to the ground, and prevents the partial obscuration of the light.

The following printed directions are pasted upon the exterior of each light:

This light must not be roughly handled or thrown about, as it is liable to be broken across at the junction of the segments. Care must be taken in removing the cap before lighting.

The case must be grasped firmly at the capped end whilst the cap, is torn off by means of the string loop. If there is any difficulty in removing the cap, it must be eased off around the edge by inserting the blade of a knife.

The lights are packed in rough lumber boxes containing three lights each.

The lights sent to Sandy Hook for trial are known as "Mark II," and were packed in July, 1877.

2.—WEIGHTS.

	Pounds.	Kilos.
Weight of wreck-light	11.5	5.18
Weight of box containing three (3) lights	61.0	27.67

Time of burning, 24 minutes and 10 seconds.

XIII.—ROCKET-BOXES.

These are oblong rectangular boxes, beveled at the upper end and covered with tarred canvas to render them water-proof The beveled top has a hinged lid fastened with a hasp, and has a projecting flap of tarred canvas hanging down over the edges to exclude the rain when carried in driving storms.

The capacity of each box is just sufficient to accommodate one rocket standing on end, without the stick. A set of cross belts or kind of harness enables the carrier to sling the box upon his back after the fashion of a knapsack. Four of these boxes accompany each set of rocket apparatus. The weight of the empty box with sling-belts is 9 pounds.

XIV.—METHOD OF USING.

With the apparatus on the ground where it is to be used, place the rocket-stand in position, giving the necessary elevation by means of the graduated arc on the side of the trough and the plummet.

Take a Boxer rocket, insert the stick through the clips and, drive in the clip-pin. Then wet about 12 feet of the end of the line and insert the end through the hole in the bottom of the rocket-stick, carry it along the stick to the hole near the upper end, draw it through and put on, first, a rubber washer, and then a brass one, and tie a knot in the end, drawing the whole down snugly upon the end of the stick. It is better to tie a knot in the line after passing it through the hole in the rear end of the stick, so that in case the line burns off between the rocket and lower end of the stick the knot will catch and the line still be carried out.

Remove the paper cap on the base of the rocket and insert a fuse. Place the rocket and stick in the trough of the stand, sliding them to the rear until the base of the rocket brings up against the front end of

the curved trough or pry-pole. Put the faking-box, slightly inclined to the front, in rear of the stand and a little to one side.

Insert a port-fire in the holder and ignite it with a detonating primer. Advance to the stand, insert the port-fire in the opening on the side opposite to that on which the faking-box and line are placed, light the rocket-fuse, and retire towards the rear.

XV.—ACTION.

As soon as the rocket composition is ignited and sufficient gas is evolved, the rocket starts, guided by the trough and the rocket-stick.

After traversing a part of its trajectory, the composition in the rear cylinder is consumed, the solid part between the cylinders burns through and sets fire to the composition in the forward cylinder, giving a new impetus to the rocket and prolonging the range.

NOTE.—The writer would here acknowledge his obligations to the "Treatise on Ammunition, 1874," by Maj. W. R. Barlow, R. A., for much information in regard to the English life-saving rockets and rocket stores.

XVI.—EXPERIMENTS WITH LIFE-SAVING APPARATUS AT SANDY HOOK, NEW JERSEY.

1.—*Record of firings with Boxer life-saving rockets and apparatus (English).*

Date.	Number of fire.	Elevation.	Kind of rocket-stand.	Life-saving rocket.				Primer.
				Caliber.	Kind.	Weight.	Total weight of rocket and stick.	
1879.		°				*Pounds.*	*Pounds.*	
Oct. 18	1	35	Boxer, Mark IV ..	12-pounder....	Boxer, III ..	14.25	17.41	Fuse, Mark I.
18	2	35	....do	....do	....do	14.25	17.41	Do.
18	3	30	....do	....do	....do	14.25	17.41	Do.
18	4	30	....do	....do	....do	14.25	17.41	Do.
20	5	29	....do	....do	....do	14.25	17.41	Do.
21	6	30	....do	....do	....do	14.25	17.41	Do.

Date.	Number of fire.	Shot-line.				With what fired.	Range.	Deviation of rocket right or left.	Drift of shot-line at 300-yard stake right or left.	Wind.	
		Material.	Number of line.	Length.	Action.					Direction.	Velocity.
1879.				*Yds.*			*Yds.*	*Feet.*	*Feet.*		*Miles per hr.*
Oct. 18	1	Italian hemp....	6	600	Good, but burned off.	Port-fire, English.	.....	.....	.....		15.9
18	2	Linen, W. P.....	6	600	Good.....	...do	.....	.....	.....		22.5
18	3	....do	6	600	Knotted and burned off.	...do	.....	.....	.....		20.0
18	4	....do	6	600	Good, two knots.	...do	540	241 R.	121 R.		18.0
20	5	Linen, W. P.; new line.	8	600	Good, one knot.	...do	511½	172 L.	126 L.		16.0
21	6	Hemp line, Russian rocket.	*8	†600	Bad.....	...do	125	6 R.	.....		16.0

NOTE.—The rocket-lines used were the Silver Lake Company's braided lines, except that used for the last round. This was a Russian hemp line, loosely "laid up"; weight, 62 pounds.
R. = Right; L. = Left; W. P. = Water-proof.

* Estimated.

2.—SYNOPTICAL TRANSCRIPT OF NOTES FROM THE FIRING RECORD.

Boxer life-saving rockets and apparatus.

Date.	No. of round.	
1879.		
Oct. 18	1	End of line attached to rocket was left dry; line burned off.
18	2	Line dry; burned off between the knots; the second knot drew through the hole in the lower end of the rocket stick when the strain came upon the line.
18	3	End of line wet; still it was burned off by the escaping flame from the rocket.
18	4	Good shot; one rubber washer placed below lower knot to prevent cutting the line should the knot be drawn through the hole in the lower end of the rocket stick; when recovered the staff was found to be broken and badly charred; the velocity of the wind at ordnance office, near the firing point, was, at the beginning of the day's experiments, 16 miles per hour; at the close, 14.6 miles per hour; the direction was very changeable; at the last shot, the wind along the first half of the trajectory was from the left and front, while it was blowing from the right and front in the farther half at the same time, as shown by the range flags that marked the line of fire.
20	5	No. 8 linen water-proof line used (new); fired from the original coil; rocket carried out all the line except six coils; wet the line below the end of the rocket-stick; the line fouled once from the coils catching on each other; one knot formed; the original coil was placed 6 feet to the right of the stand (windward), inclined to the front and backed up by sand; the knot was 200 yards from the firing point; line drifted badly after passing the 200-yard stake, and followed the drift of the rocket closely; rocket-stick charred by flame; every coil drawn out put one twist in line.
20	6	Russian rocket-line, weight, 62 pounds; line twisted, soft laid in original coil; many of the coils were loose and were expected to kink and *did* kink badly; the whirl of the line caught the coil and carried it bodily 100 yards down the range; the second knot was drawn down into the lower end of the stick, splitting it nearly to the ferrule; the rubber washer placed between the second knot and the lower end of the staff probably saved the line from being cut; the short range is accounted for by the resistance due to carrying the whole coil.

PART V.

Hooper's life-saving rocket apparatus.

I.—HOOPER'S LIFE-SAVING ROCKET.

(Plate XI.)

1.—DESCRIPTION.

This rocket is a modification of the Hale rocket. The body of the rocket is cylindrical in form, made of sheet metal 0″.165 thick. The point of the rocket or head is ogival in form, made of wood, and has a cylindrical tenon 1″.1 in length, which is inserted into the front end of the body. The head is held in position by several screws passing through the rocket-case into the tenon. The rear end of the case is closed by a metallic base carrying a double swivel and perforated with five vents or gas escapes, each one half an inch in diameter. On one side of these vents are fluted projections extending 2″.3 towards the rear, so curved as to leave the opposite sides open for the unimpeded escape of the gases evolved by combustion. The object of this arrangement is to produce a motion of rotation about the longer axis of the rocket, and thus secure greater steadiness of flight. This cast-iron base is held in position by pins passing through the case.

To the swivel is attached a chain a little over 3 feet long, to which the line is made fast. The rocket is fired by breaking the paper covering of one or more of the vents, and inserting a piece of slow match and igniting the outer end.

2.—*Principal dimensions and weights.*

		Inches.	Centimeters.
Length of body		14.5	36.82
Diameter of body	Exterior	3.75	9.40
	Interior	3.42	8.64
Head	Total length	3.6	9.14
	Length of ogival part	2.5	6.35
	Diameter	3.75	9.40
	Tenon: Length	1.1	2.79
	Tenon: Diameter	3.42	8.64
Length of base outside of case		2.7	6.86
Total length of rocket		19.7	50.03
Length filled with composition		12.0	30.48
Diameter of vents		0.5	1.27
Number of vents		Five.	
Length of chain and swivel		38″.5	96.65
		Pounds.	Kilos.
Average weight of rocket and chain		19.25	8.73

For further details in regard to construction, action, and method of using, see Mr. Hooper's description appended below. In that description is included the rocket-stand proposed by Mr. Hooper.

No rocket-stand was furnished with these rockets, consequently the weight of that portion of the apparatus is unknown.

In the experiment with the Hooper rockets made by the writer, the German rocket-stand was used throughout the trial.

H.—Directions for the use of J. Singleton Hooper's life-saving rocket and stand.

1. The elevation required for the stand to be ascertained by means of a small quadrant; 25° will carry the line 300 yards with ease.

2. It is suggested, in order to save time, that every rocket-line should be spliced to a spring swivel that it might *at once* be attached to the end of the rocket-chain.

3. *In all cases three fathoms of the rocket-line to be wetted before being attached to the chain.*

4. Place the rocket in the trough or stand with its shoulder against the small iron projection at its base, and the chain hanging down through the slot.

5. To fire the rocket: With a pointed stick break the oil paper covering each of the flange holes, insert into one of them a slow match, light and retire to an angle of 45° to the rear of the stand.

J. S. HOOPER, *R. N.*

(Copy of printed record.)

III.—Improvement in rockets.

Specification forming part of letters patent No. 196019, *dated October* 19, 1877; *application filed May* 22, 1877.

(Plate XII.)

To all whom it may concern:

Be it known that I, James Humphrey Singleton Hooper, R. N., of Sunny Croft, Croxted Road, Dulwich, in the county of Surrey, England, have invented new and useful Improvements in Rockets for saving life and other useful purposes, and in the apparatus used in connection therewith, which improvements are fully set forth in the following specification, reference being had to the accompanying drawings.

This invention has reference to those rockets known as the "Hale

rocket," and consists of improvements in the means and apparatus for adapting such rockets to life saving and other useful purposes.

The object of these improvements is to more readily carry out a line to a shipwrecked or stranded vessel with certainty, and at any angle, according to the distance or height at which it is desired to throw the rocket, and may be used as a means of communication, and for other useful purposes.

To carry out my improvements I insert through the center of the flange or tail-piece of the Hale rocket a small iron, steel, or other metal spindle, with a head to it, the head being for the purpose of resting on a circular bearing, for the purpose of retaining the spindle in position, made in the interior of the flange or tail-piece. The action of the spindle working in this bearing is what I call my "first swivel." To the end of this pin or small spindle, which projects beyond the end of the flange of tail-piece, I attach a swivel-bow or other mechanical equivalent being capable of rotation, and this I call the "second swivel," thus making a complete double swivel, to which is attached a short length of chain. The swivel and chain being both clear of the rear fire I can, without burning, attach any description of line.

And in order that my said invention may be properly understood and carried into effect, I will now proceed to describe the same, reference being had to the annexed drawings (Plate XII) and to the letters and figures marked thereon.

Figure 1 represents an external view of rocket known as a "Hale rocket," and shows my improvements attached thereto. Fig. 2 represents a longitudinal section of the same, and shows more fully the internal mechanism and my double swivel. Fig. 3 represents a transverse section of the rear end of the rocket, taken on the line A B. Fig. 4 represents a transverse section through the tail-piece or rotator on the line C D.

To carry out these improvements I insert (for about half its length) through the center or longitudinal axis of the tail-piece or rotator *j* a spindle or bolt, *n*, with a collar or head, *o*, at that end of it which is within the tail-piece or rotator *j*. This tail-piece or rotator is recessed to receive the collar or head of the spindle or bolt *n*, so that the under side of the collar, or head *o*, bears against the shoulder *p*, formed by the recess in the tail-piece or rotator *j*, by which arrangement, though the spindle or bolt *n* is retained in its position in rotator *j*, and securely held within the same by the collar or head *o*, so that it cannot be withdrawn, yet it is perfectly free to turn or rotate on its own axis (after the well known manner of a journal in its bearing), and this I call, from its having such a rotary action about its axis, my "first swivel." Further, to that end of this same spindle or bolt *n* which projects beyond the tail-piece or rotator *j*, I attach an ordinary swivel-bow or shackle, *g*, free to turn or rotate on the aforesaid bolt *n* but securely retained to the same by the nut *r* on the screwed end of the spindle or bolt *n*. This nut is also further secured from unscrewing by the cross-pin *s* passing through the same.

The second swivel (bow) works on the steel bolt in a recess, *g'*, cut in the rear of tail-piece. The swivel is, therefore, safely protected from the back fire injuring its working faces. This last-described swivel-bow *g* (or shackle free to turn on its axis) I call my "second swivel," and to it is attached a small length of chain, *t*, to the end of which is fastened one end of the rope or cord to be carried out.

It will be seen by this combination of parts which I have adopted, the greatest liberty is given to the rocket to rotate on its axis free from any impeding action to such rotation by the rope attached as is experi-

enced in the stick-rocket at present in use, and to supersede which is one of the real objects of this invention; for in my method the whole of the parts, both of the rocket proper and also the double swivel, as well as the chain itself, is equally balanced about the axis of rotation, and therefore these parts do not impede the equal action of rotation, nor tend to cause the rocket to deviate from its true path of flight.

By the double swivel-action of my invention I effectually guard against the danger of one swivel not acting, for should one of them cease to act there is still the other swivel, which is perfectly capable of performing all that is required, so that the first or the second swivel may severally perform, apart from any assistance from the other, its proper, office of permitting the rocket to rotate without itself or chain attachment and rope rotating; or they (the swivels) both may share more or less equally between them their functions, thus insuring in my case a perfect swivel-action between the rocket proper and the rope.

The cavity at the back of the head *o* of the bolt *n* is plugged with a plug, *u*, which protects the bolt from damage. This plug *u* is made parallel, and the head u^2 is coned, thereby diverting the fire into the flange-holes more readily, and the shoulder under the head, in conjunction with the tight fit, when resting on a similar circular bearing to that on which the bolt-head *n* rests, effectually secures the head of the bolt *n* from damage while the combustion of the composition a^1 is going on in the case *a* during the flight of the rocket, the space between the two bearings being filled with tallow.

Fig. 5 represents a side elevation of the stand from which the rocket is fired, and Fig. 6 the back end view of the same to a larger scale.

This stand consist of two pieces, *v* and *v'*, of wood, iron, or other suitable material (when of the first-mentioned substance they are covered with thin sheet-iron), fastened together parallel to each other, with their upper surfaces inclined to one another about one hundred and sixty degrees, or thereabout. These pieces *v v'* are connected, at three or more places, by semicircular bands or hoops *w*, of iron or other suitable material, which bridge from the outside of one piece, *v*, to the outside of the other piece, *v'*. The near sides of these pieces, *v* and *v'*, are placed at such a distance apart that the chain *t* and rope *x*, connected to the tail of the rocket, may be able to freely pass between them without any danger of its being caught by the sides.

The stand is supported at the front end by two double-jointed legs, *y*, with spikes at their extremities or bases, and is supported at the rear end by two shorter legs, *z*, of iron or other material. There is a small projection, *z'*, on one of the pieces *v* and *v'*, for the rear end of the rocket to rest against when it is fired, which is performed by a slow match or fuse.

Another advantage of my invention is, that the improvements adopted are very light and portable, and require but a simple stand (already described) to fire from, thus doing away with the complicated machinery at present in use with the stick life-saving "boxer" or other rocket.

Having thus described the value and object of my said invention, I claim—

1. The combination, with the Hale rocket, of a swivel, to which the line is attached, secured to the tail-piece of said rocket, whereby the line is carried without being twisted by the rotation of the rocket, substantially as described.

2. The combination, with the tail-piece *j*, of the bolt *n*, rotating freely in said tail-piece, and the swivel *g*, secured to the end of the said bolt, constructed and arranged substantially as described and shown.

3. The combination, with the tail-piece *j*, of the plug *u*, having a conical head, u^2, for protecting the swivel-bolt and diverting the fire into the flange-holes, constructed and arranged substantially as described and shown.

JAMES HUMPHREY SINGLETON HOOPER.

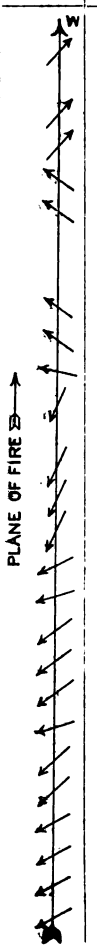
Witnesses:
GEO. DOWNING.
GEO. FORBES.

IV.—EXPERIMENTS WITH HOOPER'S LIFE-SAVING ROCKETS.

EXPERIMENTS WITH LIFE-SAVING APPARATUS AT SANDY HOOK, NEW JERSEY.

1.—*Record of firings with the Hooper life-saving rocket.*

Date.	Number of fire.	Elevation, degrees.	Kind of rocket-stand.	Rocket, kind of.	Primer.	With what fired.	Where fired.	Line attached or not.	Rocket exploded in air or not.	Wind. Direction.	Wind. Velocity.
1879.		°									
Oct. 20	1	26.5	German.	Hooper life-saving.	Slow match.	German pillenlicht.	On beach..	Yes.	No.		
20	2	26.5	...do	....do	..do....	....do	....do	Yes.	No.		
20	3	26.5	...do	....do	..do ...	....do	....do	Yes.	Yes.		
21	4	32	...do	....do	..do....	....do	....do	Yes.	Yes.		
21	5	32	...do	....do	Train quick match.	....do	....do	Yes.	Yes.		
21	6	32	...do	....do	..do....	....do	....do	Yes.	Yes.		
22	7	30	...do	....do	..do....	....do	Out to sea..	No.	Yes.		
22	8	30	...do	....do	..do....	....do	....do	No.	Yes.		
22	9	30	...do	....do	..do....	Port-fire, U. S.	On beach..	No.	Yes.		
22	10	30	...do	....do	..do....	....do	....do	No.	Yes.		
22	11	30	...do	....do	..do....	....do	....do	No.	Yes.		
22	12	30	...do	....do	..do....	....do	....do	No.	Yes.		
Nov. 14	13	30	...do	....do	..do....	....do	Out to sea..	No.	Yes.		
14	14	30	...do	....do	..do....	....do	....do	No.	No.		
14	15	30	...do	....do	..do....	....do	....do	No.	Yes.		
14	16	30	...do	....do	..do....	....do	....do	No.	Yes.		
14	17	30	...do	....do	..do....	....do	....do	No.	Yes.		
14	18	30	.. do	....do	..do....	....do	....do	No.	Yes.		
14	19	30	...do	....do	..do....	....do	....do	No.	Yes.		
14	20	30	...do	....do	..do....	....do	....do	No.	Yes.		
14	21	30	...do	....do	..do....	....do	....do	No.	Yes.		
14	22	30	...do	....do	..do....	....do	....do	No.	Yes.		
14	23	30	...do	....do	..do....	....do	....do	No.	Yes.		
14	24	30	...do	....do	..do....	....do	....do	No.	Yes.		



2.—SYNOPTICAL TRANSCRIPT OF NOTES FROM THE FIRING RECORD.

Hooper's life-saving rocket, using the German rocket-stand.

Date.	No. of round.	
1879.		
Oct. 20	1	Italian hemp line, Silver Lake, No. 7. Rocket carried out about 300 yards of line, when it burned off the line near the chain. Rocket-chain too short—length 37 inches. Faking-box and line placed at the right of the rocket-stand, and a little in rear of it. The position of the box and line appeared to change the direction of the rocket about 20° to the left of the line of fire. The line ran out beautifully until burned off, 300 yards away. No stand furnished with the Hooper rockets; had to use the German stand.
20	2	Same line, in coils, hauled in hand-over-hand. Line broke; probably fouled in the coils and cut by drawing through. Action of rocket good. Range of rocket over 700 yards at least.
20	3	No. 7 line. Line cut by sharp corners on legs of stand. Rocket carried away a piece of the line. Range unknown. Rocket burst in the air beyond the 400-yard stake.
21	4	No. 7 hemp line. Wet 10 feet of the line. Range 175 yards; deviation of rocket to left of line of fire 42 feet. Rocket exploded, blew out front end of the rocket, and dropped to the ground as soon as the explosion took place.
21	5	Same line hauled in hand-over-hand. Rocket blew up in the trough of the rocket-stand. Head blew out and rocket fell backward out of the stand.
21	6	Same line. Rocket exploded in the air 150 yards from firing point; carried off piece of line; coils caught. Line cut by drawing through the coils. Range 280 yards. The line lay in loose coils as hauled in.
22	7	No line; rocket exploded in the air.
22	8	No line used from this time until end of experiments with this rocket. Rocket burst in the air 1½ seconds from instant of leaving trough.
22	9	Exploded in 1½ seconds after leaving trough.
22	10	Exploded in the trough ½ second after composition was lighted. The breech was blown out and the rocket-case ruptured from end to end. Gas and sand blown in face of firer, who had a narrow escape from being seriously injured.
22	11	Long trains of quick match used from this time out to enable firer to reach a safe distance. Rocket exploded about 300 yards out. Flight of rocket regular until it burst. Time lost.
22	12	Rocket exploded 20 yards in front of stand.
Nov. 14	13	Rocket exploded in the air.
14	14	Fired out to sea; good range. Rocket did not explode.
14	15	Burst immediately in front of stand.
14	16	Rocket burst 200 yards out.
14	17	Burst short distance in front of stand.
14	18	Burst 20 yards in front of stand.
14	19	Rocket burst 30 yards in front of stand.
14	20	Rocket exploded in front of stand.
14	21	Same remark.
14	22	Rocket exploded 50 yards in front.
14	23	Rocket exploded in the air.
14	24	Rocket exploded in the air.

PART VI.

Conclusion.

I.—RECAPITULATION OF WEIGHTS.

1.—*Russian life-saving rocket apparatus.*

	Pounds.	Kilos.
Weight of rocket and stick	25.5	11.56
Weight of rocket-stand	39.0	17.68
Weight of rocket-chain	4.625	2.19
Weight of portfire handle	.5625	0.25
Total weight	69.6875	31.69

2.—5^{cm} *German life-saving rocket apparatus.*

	Pounds.	Kilos.
Weight 5 ^{cm} rocket	10.	4.53
Weight of rocket stick and chain	5.5	2.49
Weight of rocket-stand	35.	15.98
Weight of firing-staff	2.	0.91
Total weight	52.5	23.91

3.—8cm *German life-saving rocket apparatus.*

	Pounds.	Kilos.
Weight of 8cm rocket	35.0	15.98
Weight of rocket stick and chain	7.25	3.29
Weight of rocket-stand	35.	15.98
Weight of firing-staff	2.	0.91
Total weight	79.25	36.16

4.—8cm *German anchor-rocket apparatus.*

	Pounds.	Kilos.
Weight of 8cm anchor-rocket	37.375	16.95
Weight of rocket stick and chain	9.	4.08
Weight of rocket-stand	35.	15.98
Weight of firing-staff	2.	0.91
Total weight	83.375	37.92

5.—*English life-saving rocket apparatus.*

	Pounds.	Kilos.
Weight of rocket	14.25	6.46
Weight of rocket-stick	3.16	1.43
Weight of rocket-stand	30.	13.60
Weight of rocket carrying-box	9.	4.08
Total weight	56.41	25.57

6.—*Hooper life-saving rocket system.*

	Pounds.	Kilos.
Weight of rocket and chain	19.25	8.73

The other weights in this system are unknown.

A glance at the above figures will show that the great advantage of rocket systems lies in their small weight and extreme portability.

The faking boxes and lines have been omitted in the above comparison, as their weights would differ but little from each other in the several services, provided the same size faking-line was used.

II.—Russian rocket apparatus.

The Russian system is the most unwieldy rocket apparatus that was tried. The stand is inconvenient to handle. The tube from its form is liable to be collapsed and disabled. The manner of attaching the chain to the line is objectionable, as it increases the weight of line (already a heavy one, 62 pounds) and faking-box. The chains must be spliced to the lines in advance and kept ready for use. Again, the sudden jerk upon the chain as the hook on the rocket-stick picks it up is very apt to break the chain, made, as it necessarily is, of a rigid material. The rockets themselves were very unsatisfactory, nearly all of them exploding. In general the case obtained relief from the pressure of the imprisoned gas by blowing out the base. The great number of vents surrounding the screw-hole in the base weakens this part by diminishing the thickness of the walls between the holes. The rupture usually took place through these vent partitions.

The firing record shows that this system is unreliable.

III.—The German rocket apparatus.

None of these rockets failed and the ranges obtained are good. The drift of the rocket from the plane of fire, due to the influence of the wind, is very marked. This is to be expected in any class of projectiles that are growing lighter all the time while describing their trajectories.

The effect of the wind will generally be more noticeable in the falling branch of the trajectory when the composition is nearly or quite burned out and the rocket is rapidly losing its velocity.

The whole of the German apparatus bears evidences of that careful workmanship and painstaking in details which characterize their fabrications. Every part is substantial and is made of the best material.

The German rocket-stand gave universal satisfaction, and was the favorite among the surfmen. These rockets are very expensive, and would make ordinary practice drills very costly affairs. The cost of the rockets is as follows:

5^{cm} life-saving rocket	$3.60
8^{cm} life-saving rocket	5.80
8^{cm} anchor rocket	24.24

It will be seen from the above prices what would be the cost of a single shot with either of the rockets, forming quite a contrast with the ordinary practice shots in the United States life-saving service, which cost less than seven (7) cents each.

In the latter service old lines may be used for practice with light charges. In the case of rockets, where the charges cannot be reduced at will, good lines must be used for the exercises, as old or worn lines would be continually breaking.

It has been recommended that the German rockets be still further tested, which will be done at an early date. The German rockets being so strong and well made have inspired greater confidence in the surfmen of the upper Jersey coast than any of the other rockets. And even with these they prefer to insure safety by retiring to a distance after igniting the fuse.

IV.—English rocket apparatus.

The Boxer rocket is so well known as to require no special mention of its peculiarities. Like all rockets it is somewhat erratic in its flight, and the more so probably from the position of its stick upon the side. It has grave disadvantages in this, that should it, by the wind or from any other cause, veer slightly from its original direction when the second rocket in front ignites, it gives an impulse entirely in the wrong direction. Plate XIII shows the effect on two Boxer rockets arising from winds blowing from right to left. In the first case the rocket "ran up into the eye of the wind," in the second the rocket and line floated off bodily to the left with the wind. This apparatus appears to be too complicated. Too many detonating primers, fuses, portfires, holders, boxes, tin cylinders, washers, and clip-pins to suit life-saving crews along our coast. As one surfman aptly remarked while working with it, "there is too much *tender* work about this thing." There is yet trouble in fixing the sticks to the rockets, though the clip-pin holes have been placed in front of the clip.

English officers have found fault with the keeping qualities of these rockets. The effect of storage on those at Sandy Hook will be rendered apparent at the next inspection and trial.

V.—Hooper life-saving rockets.

These rockets failed very badly. Nearly all of them exploded, some of them before leaving the trough of the rocket-stand. Several of these were very dangerous. Captain Patterson was slightly injured by the

explosion of one of these rockets. After that the men all retired to bomb-proofs, and the rockets were fired by trains of quick match.

The heads blew out frequently, but occasionally one was ruptured longitudinally. The chain is too short, allowing the line to be burned off.

These rockets appear to be very carelessly manufactured.

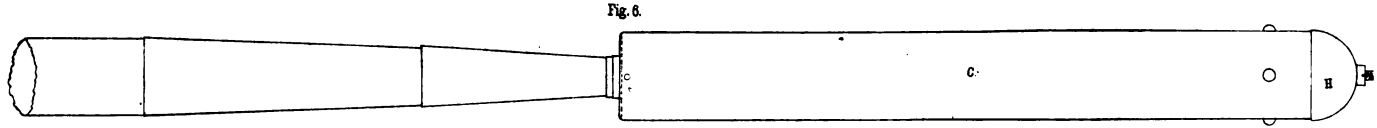
VI.—General remarks.

These trials have shown that life-saving rockets should not be handled by persons unacquainted with the necessity for avoiding jars and shocks. If, in transportation, the packing-boxes are roughly treated, the shocks communicated to the rockets cause more or less vibration, and gradually loosen the case from the composition. This effect is hastened by changes of temperature expanding and contracting the metal cases.

As soon as the composition gets a little loose in the case, cracks are liable to be found extending from the *bore* to the case. These openings allow the fire to penetrate between the rocket-case and composition enveloping the latter in flames, and setting free an amount of gas which the case is unable to sustain. With this violent pressure it is not strange that many of the rockets should burst explosively.

The liability to injury from corrosion where exposed to the moist sea air is always present, no matter what rocket system be used.

In short it may be said that with rockets one never knows what may happen, nor where they will go when fired.



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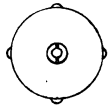

Fig. 2.

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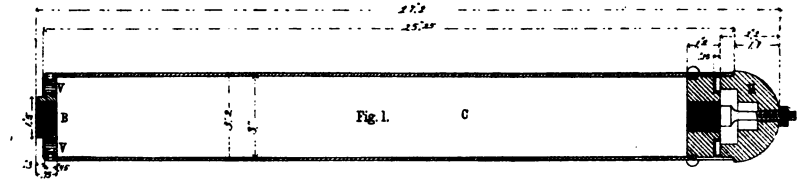

Fig. 1.

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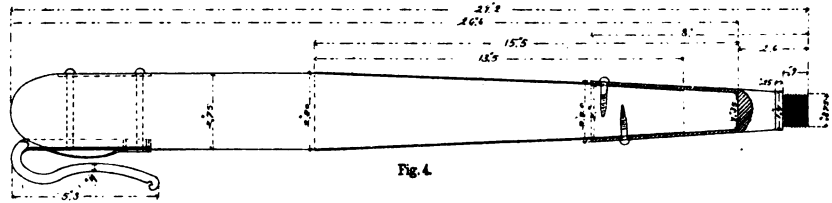

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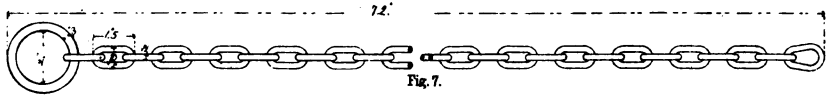


Fig. 7.

LIFE-SAVING APPARATUS.

RUSSIAN LIFE-SAVING ROCKET,

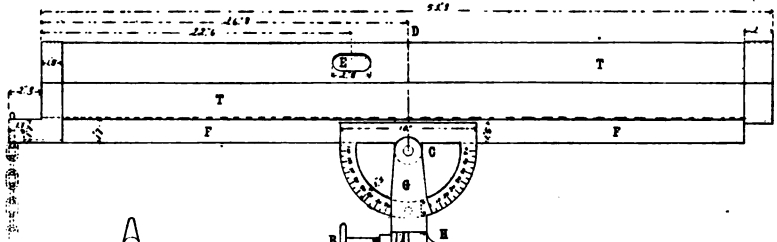
AND

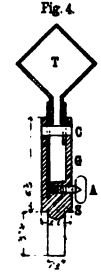
ROCKET CHAIN.

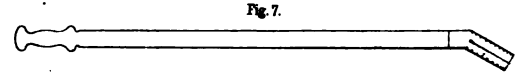
1880.

PLATE I.

Appendix 14—1880.







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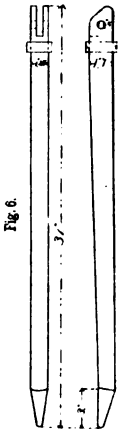
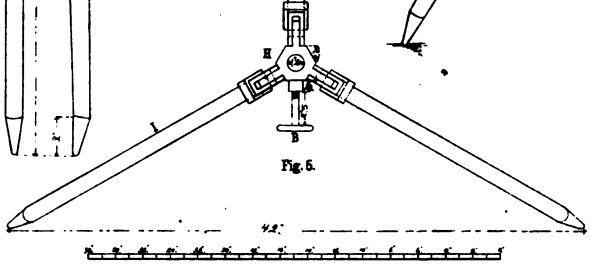




LIFE-SAVING APPARATUS.

RUSSIAN ROCKET STAND,

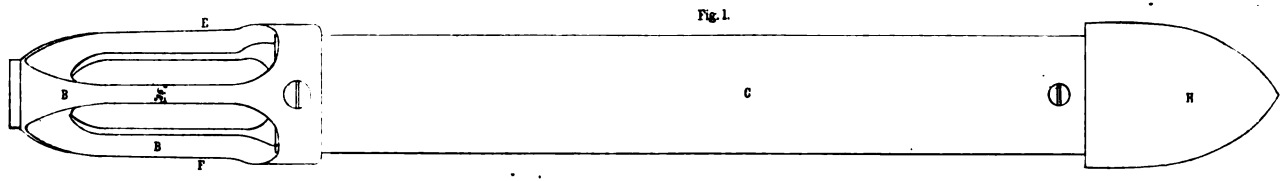
AND

Port-fire Holder.

1880.

PLATE II.

Appendix 14—1880.



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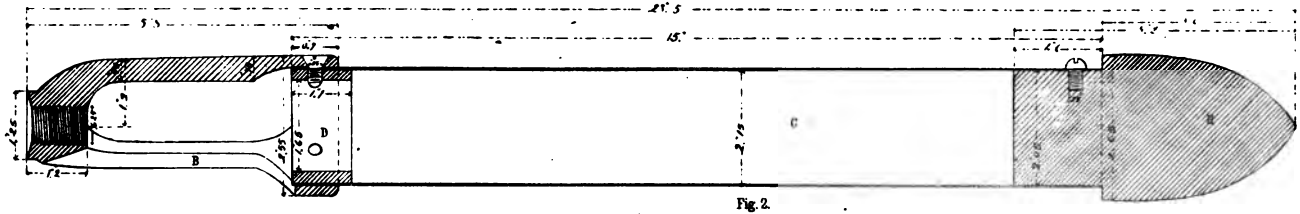

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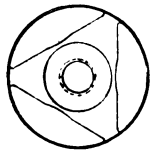

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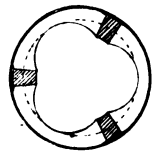

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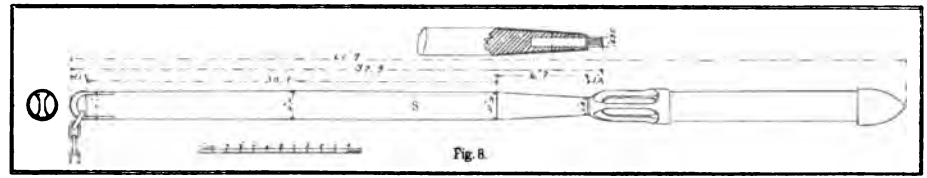

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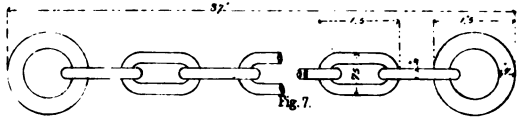

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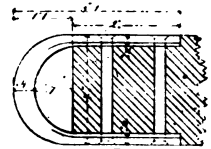

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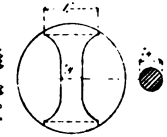


Fig. 6.

LIFE-SAVING APPARATUS.

6-CENTIMETER

GERMAN LIFE-SAVING ROCKET.

AND

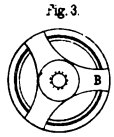
Rocket Stick and Chain.

1880.

PLATE III.

Appendix 14—1880.

Fig. 4.



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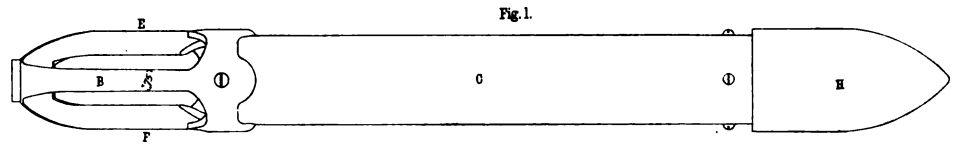

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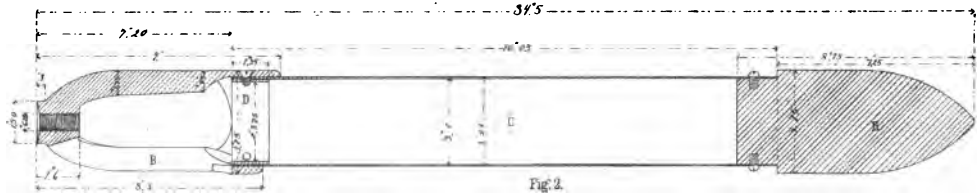

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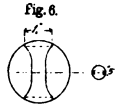

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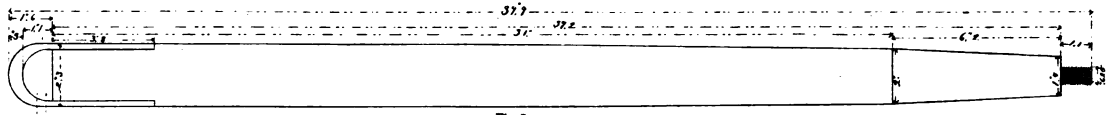

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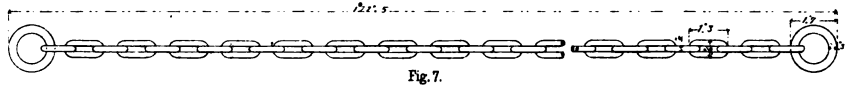

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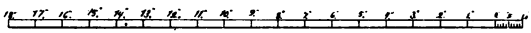


LIFE-SAVING APPARATUS.

8-CENTIMETER

GERMAN LIFE-SAVING ROCKET,

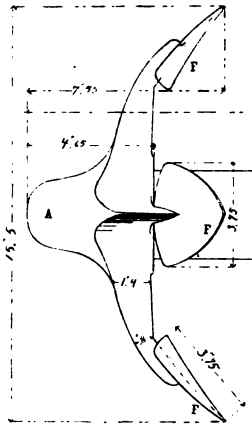
—AND—

Rocket Stick and Chain.

1880.

Appendix 14—1880.

PLATE IV.



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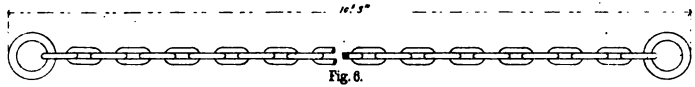

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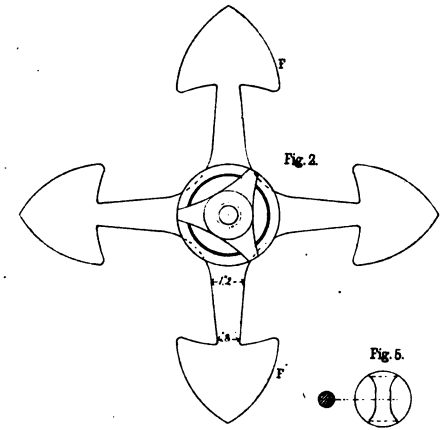

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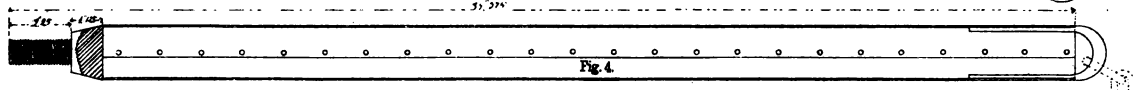

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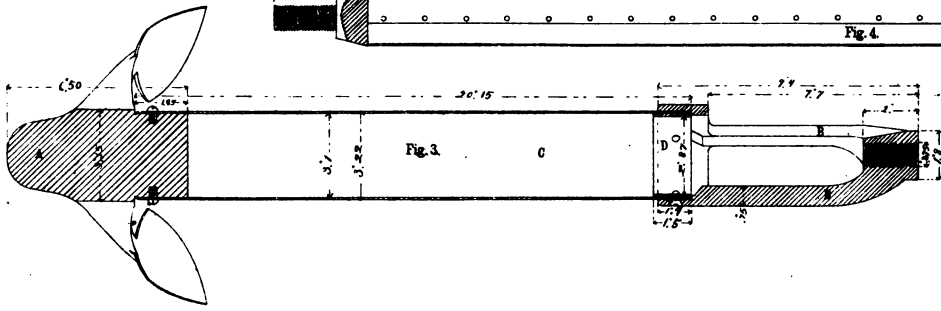

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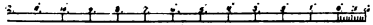


Appendix 14—1881

LIFE-SAVING APPARATUS.

8-CENTIMETER

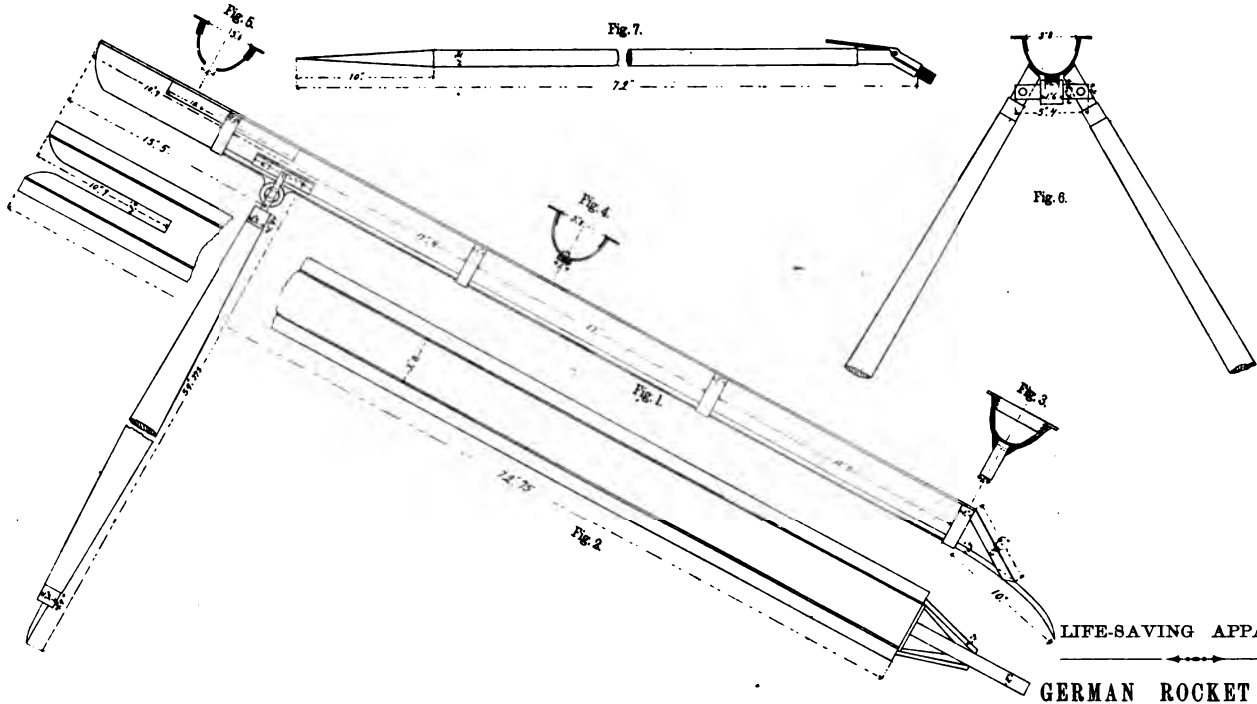
GERMAN ANCHOR ROCKET,

AND

Rocket Stick and Chain.

1880.

PLATE V.



LIFE-SAVING APPARATUS.

GERMAN ROCKET STAND,

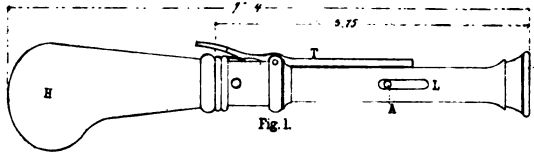
AND

FIRING STAFF.

1880.

PLATE VI.

Appendix 14—1881.



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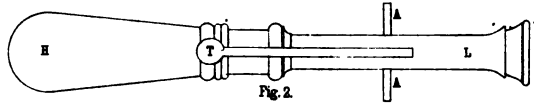

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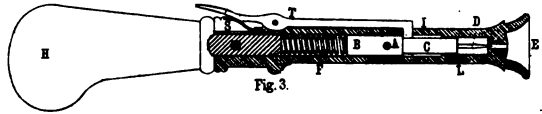

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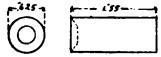

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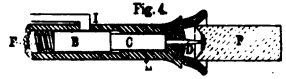

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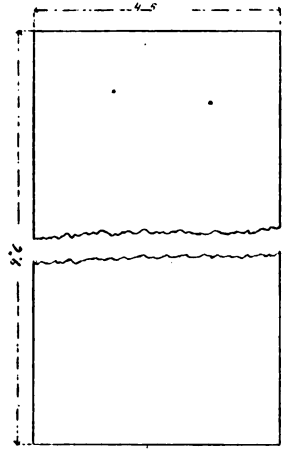

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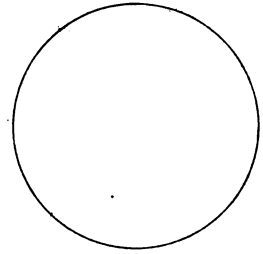

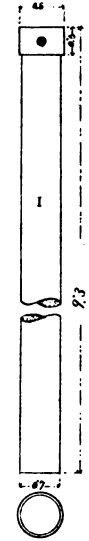

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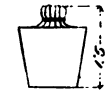
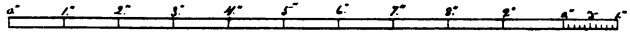


Fig. 8.



Appendix 14—1880.

LIFE-SAVING APPARATUS.

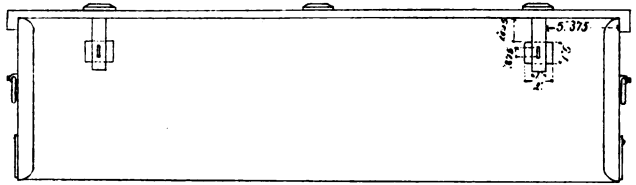
GERMAN
FIRING-LOCK AND PILLENLICHT,

AND

English Port-fire and Port-fire Cylinder.

1880.

PLATE VII.



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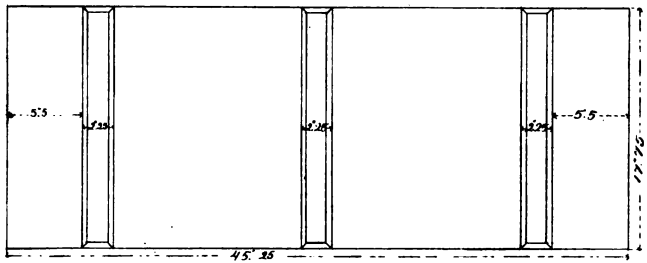

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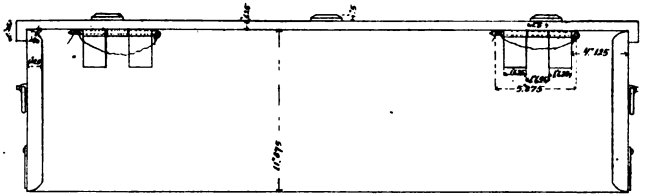

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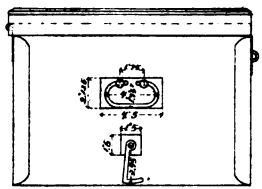

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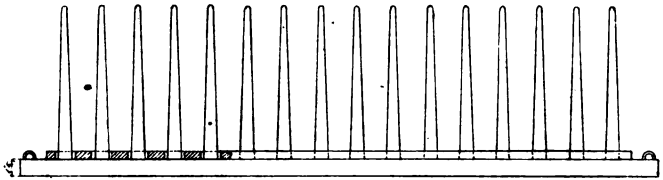

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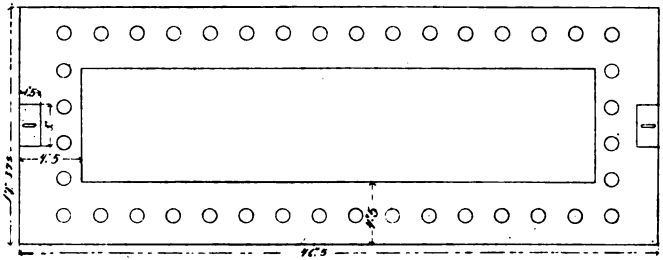


Fig. 6.

LIFE-SAVING APPARATUS.

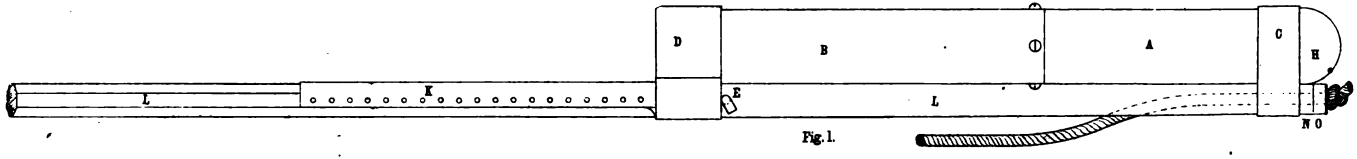
GERMAN FAKING BOX,

SHOWING

Frame and Faking Pins.

1880.

PLATE VIII.



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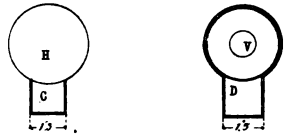
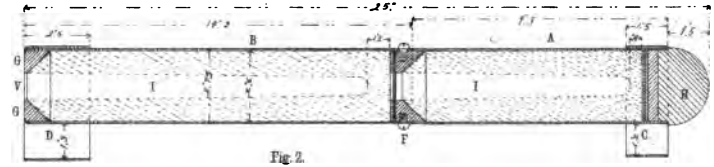


Fig. 4. Fig. 3.



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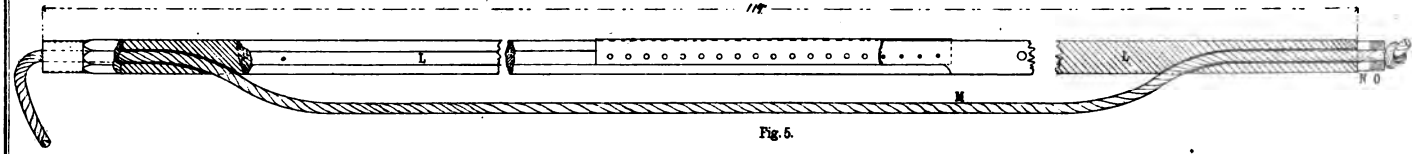


Fig. 5.

LIFE-SAVING APPARATUS.

ENGLISH LIFE-SAVING ROCKET,

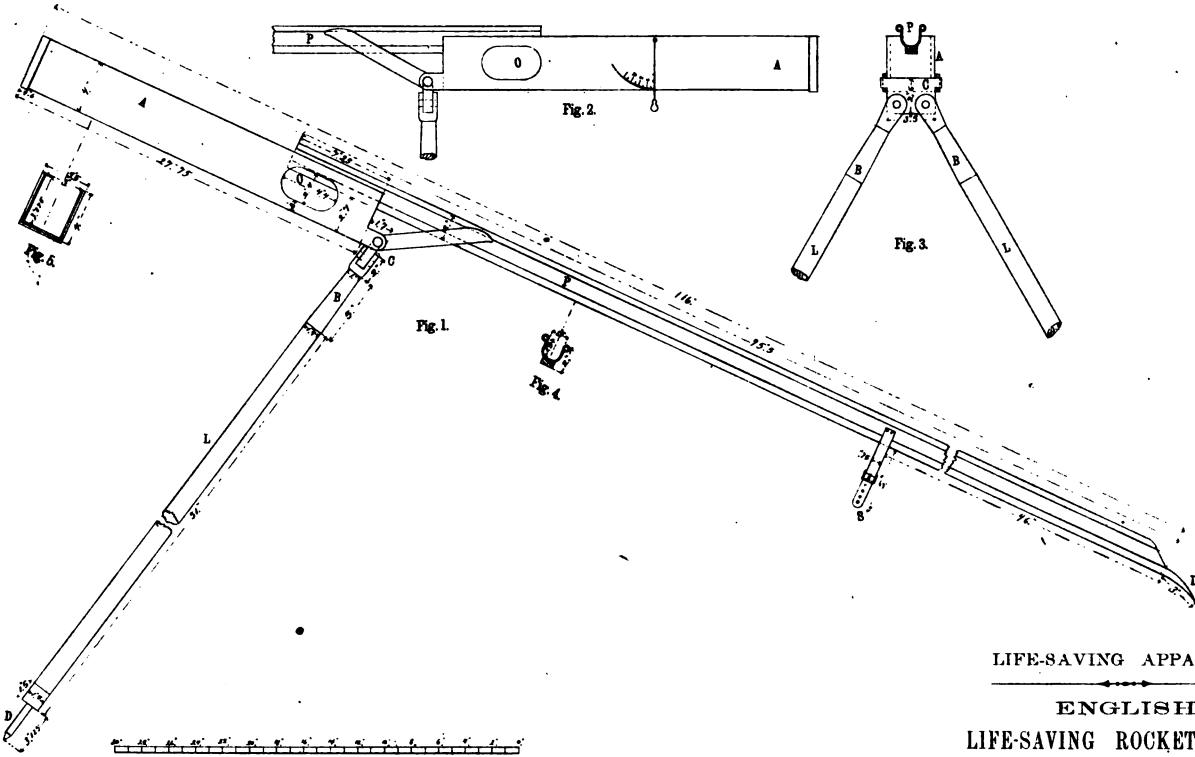
AND

ROCKET STICK.

1880.

Appendix 14—1880.

PLATE IX.



LIFE-SAVING APPARATUS.

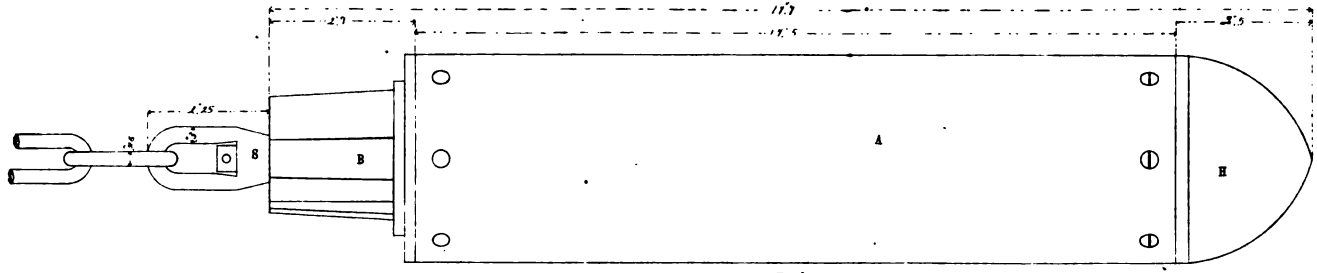
ENGLISH
LIFE-SAVING ROCKET STAND,

(Weight, 30 Pounds.)

1880.

PLATE X.

Appendix 14—1880.



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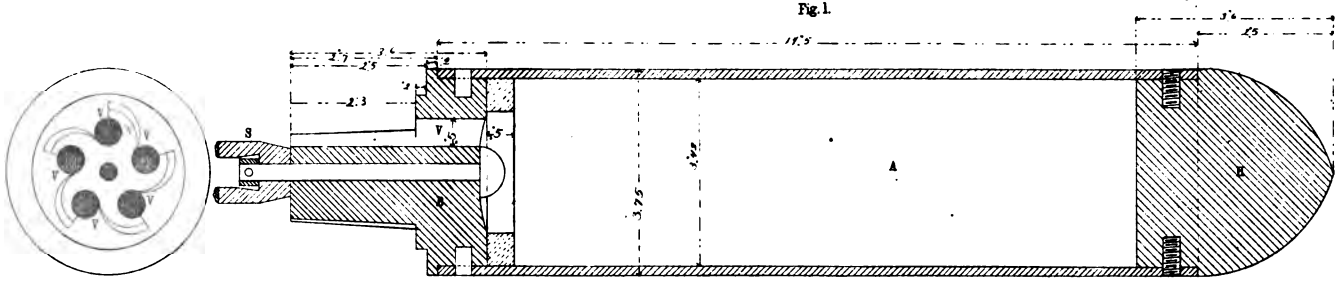


Fig. 3.

Fig. 2.

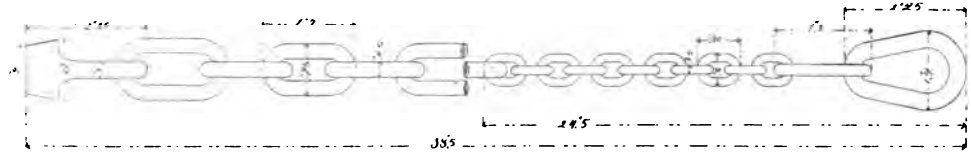
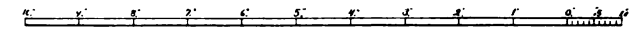


Fig. 4.



LIFE-SAVING APPARATUS.

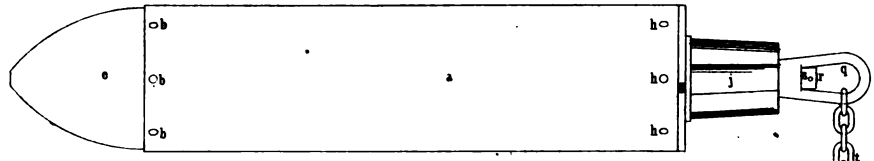
HOOPER'S LIFE-SAVING ROCKET

And Chain, (English).

1880.

PLATE XI.

Appendix 14—1880.



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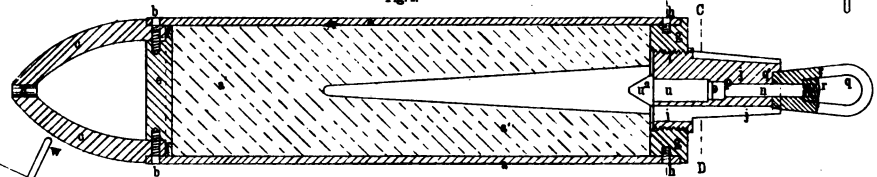

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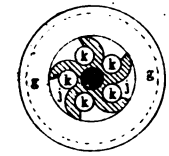

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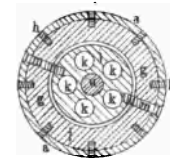

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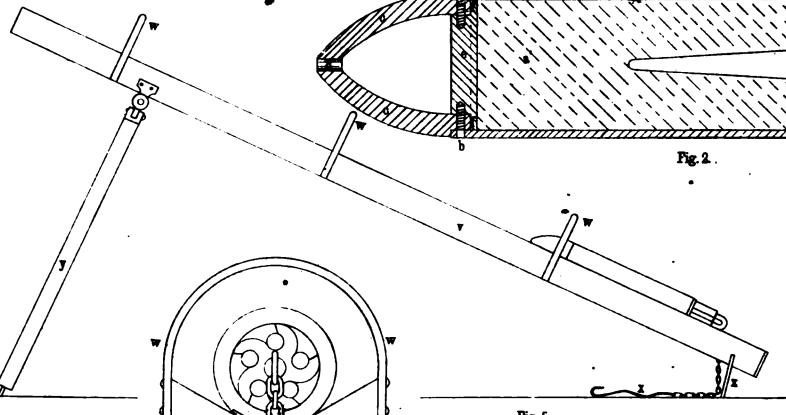

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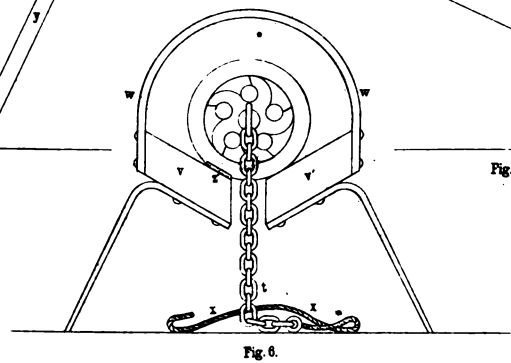


Fig. 6.

LIFE-SAVING APPARATUS.

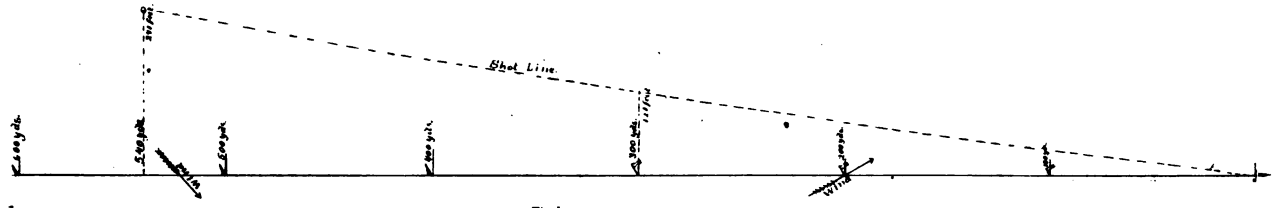
HOOPER'S LIFE-SAVING ROCKET,

AND

Rocket Chain and Stand.

1880.

PLATE XII.



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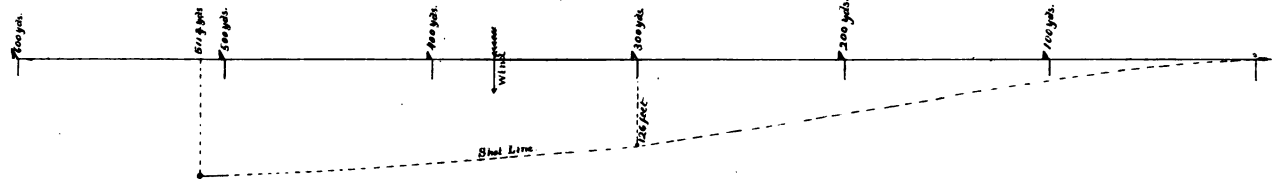


Fig. 2.

LIFE-SAVING APPARATUS.

DIAGRAMS

—SHOWING—

THE EFFECTS OF THE WIND

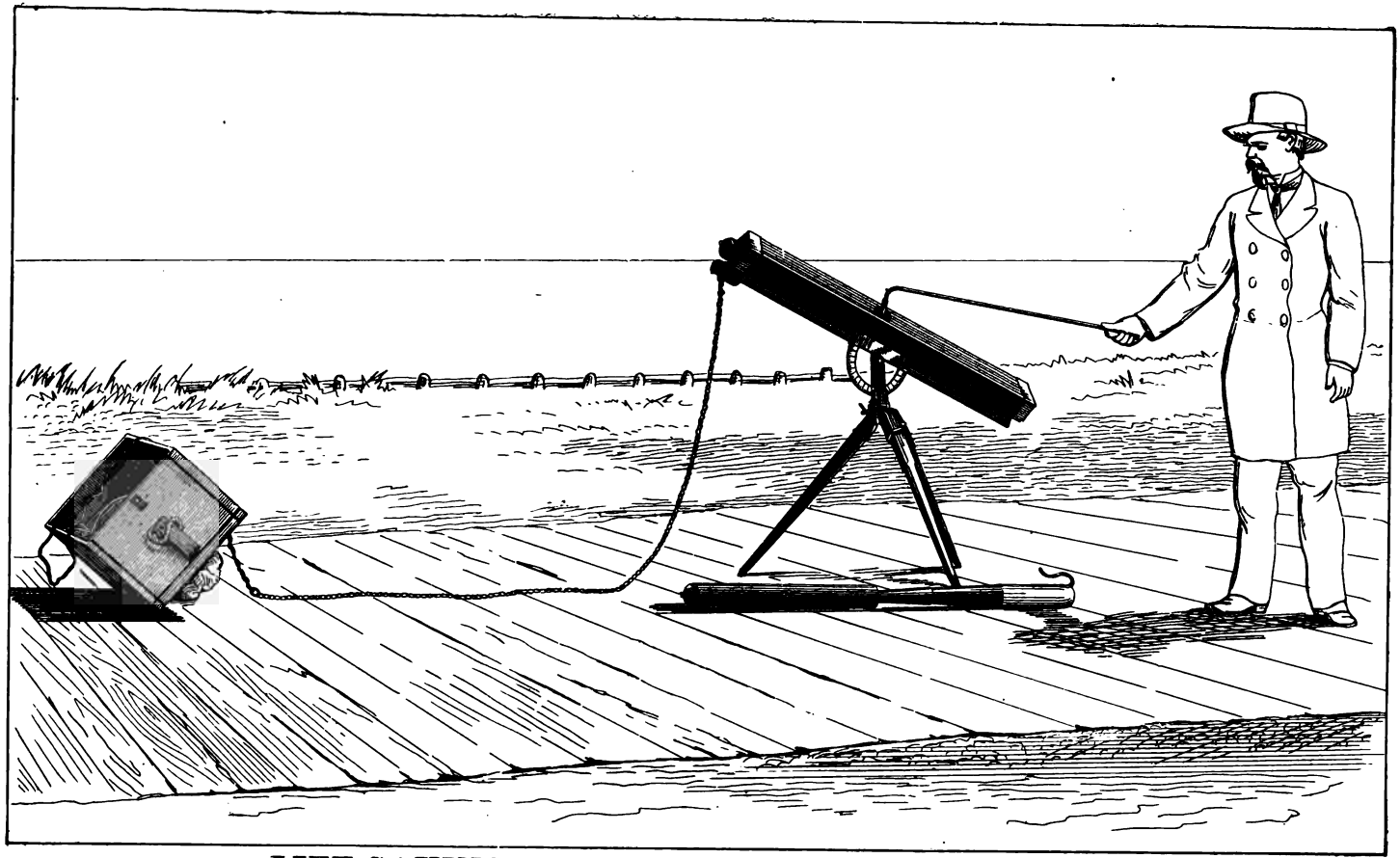
—UPON THE—

Trajectories of English Life-Saving Rockets.

1880.

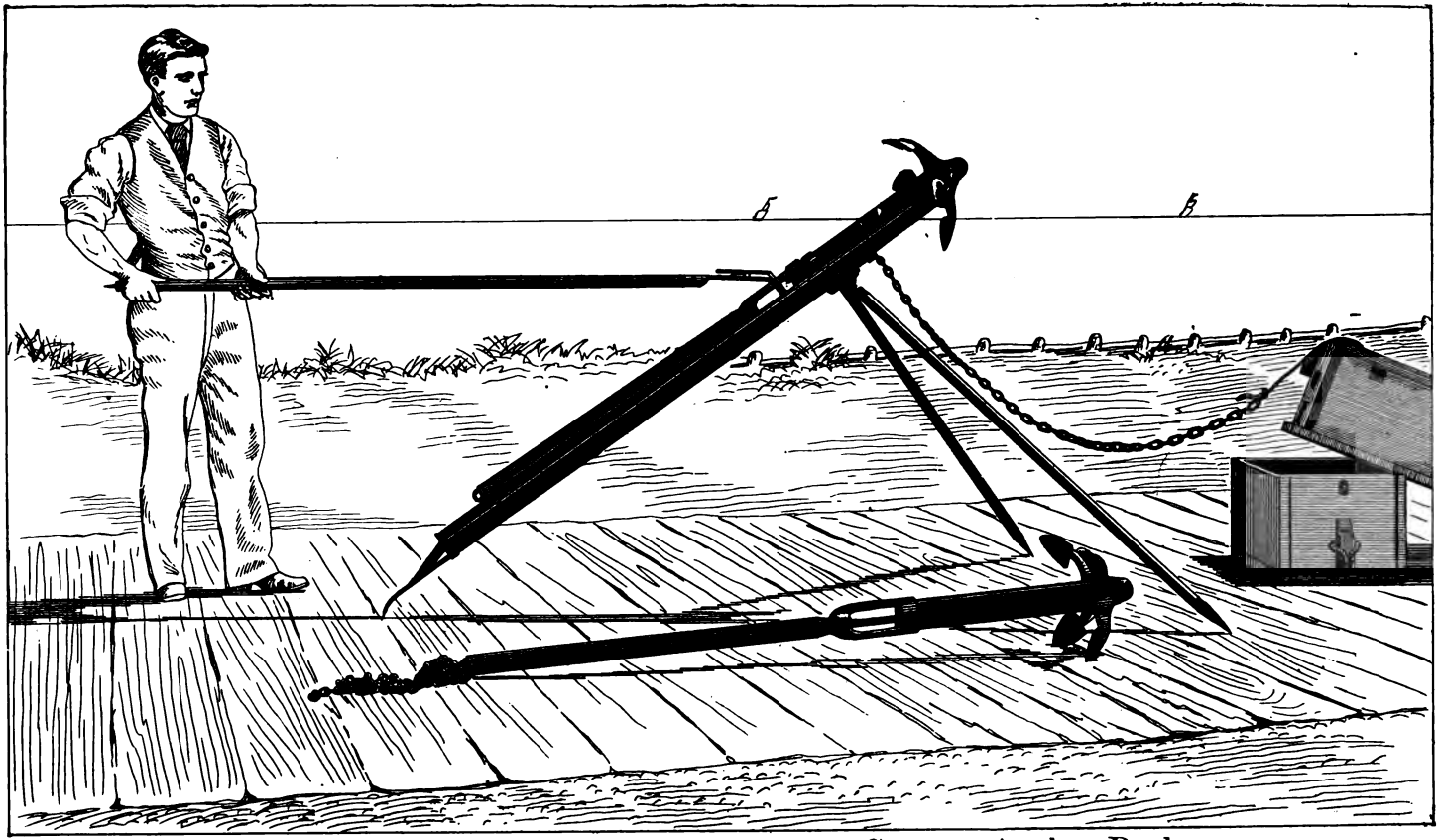
PLATE XIII.

Appendix 14—1880.



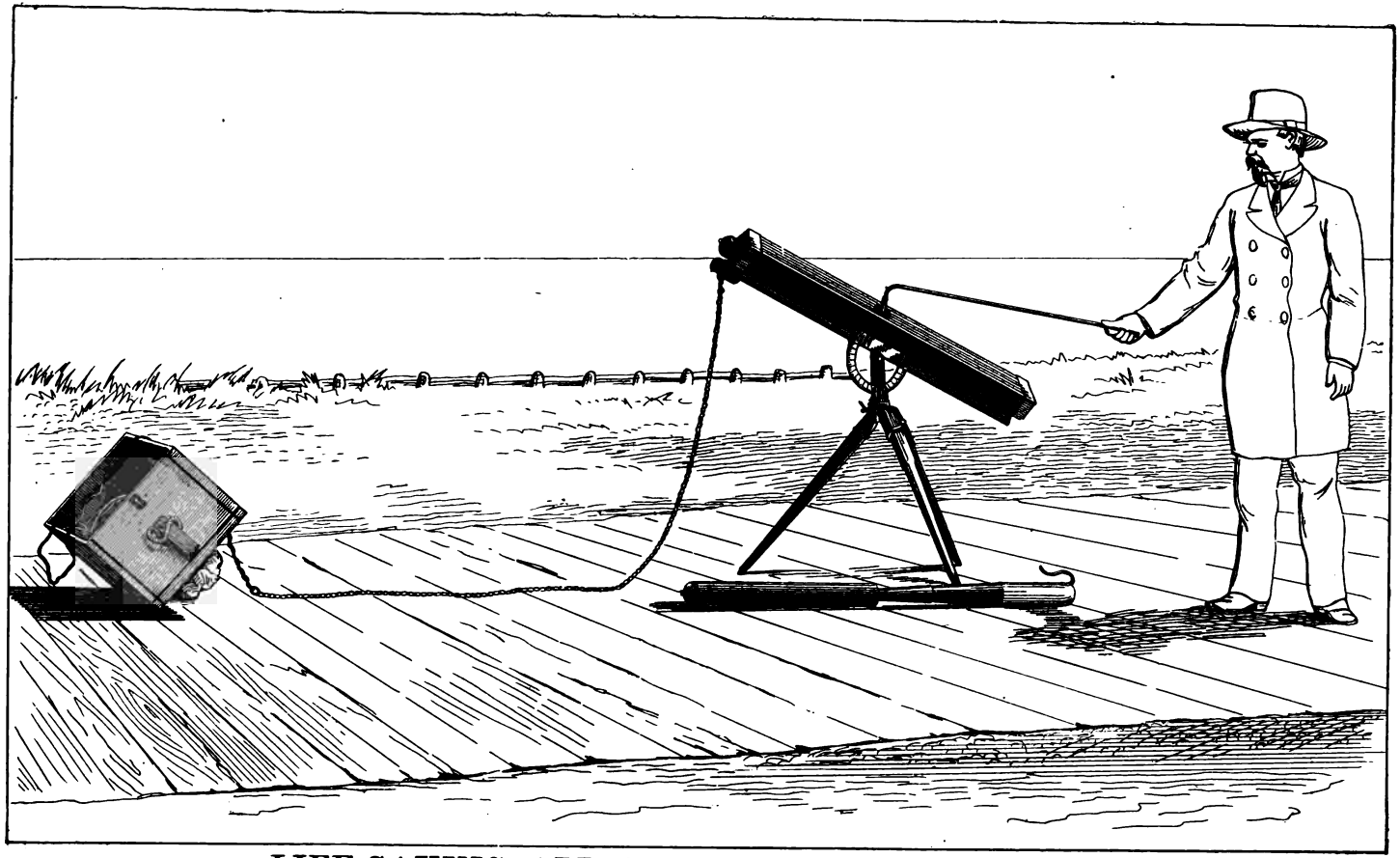
LIFE-SAVING APPARATUS.—Russian Rocket System.

LIFE-SAVING APPARATUS.—8 cm. German Rocket System.

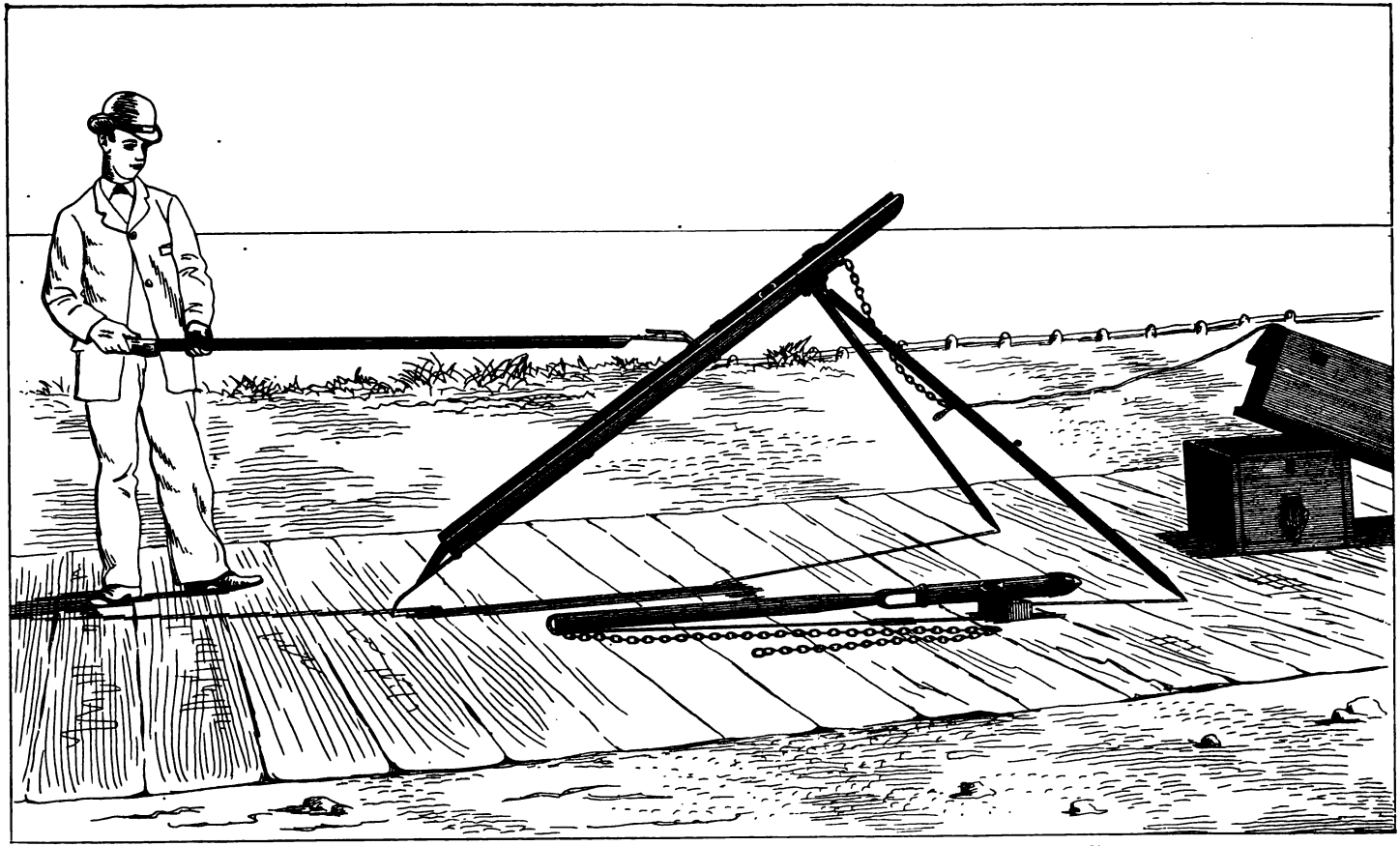


LIFE-SAVING APPARATUS.—8 cm. German Anchor Rocket.

LIFE-SAVING APPARATUS.—English Rocket System.

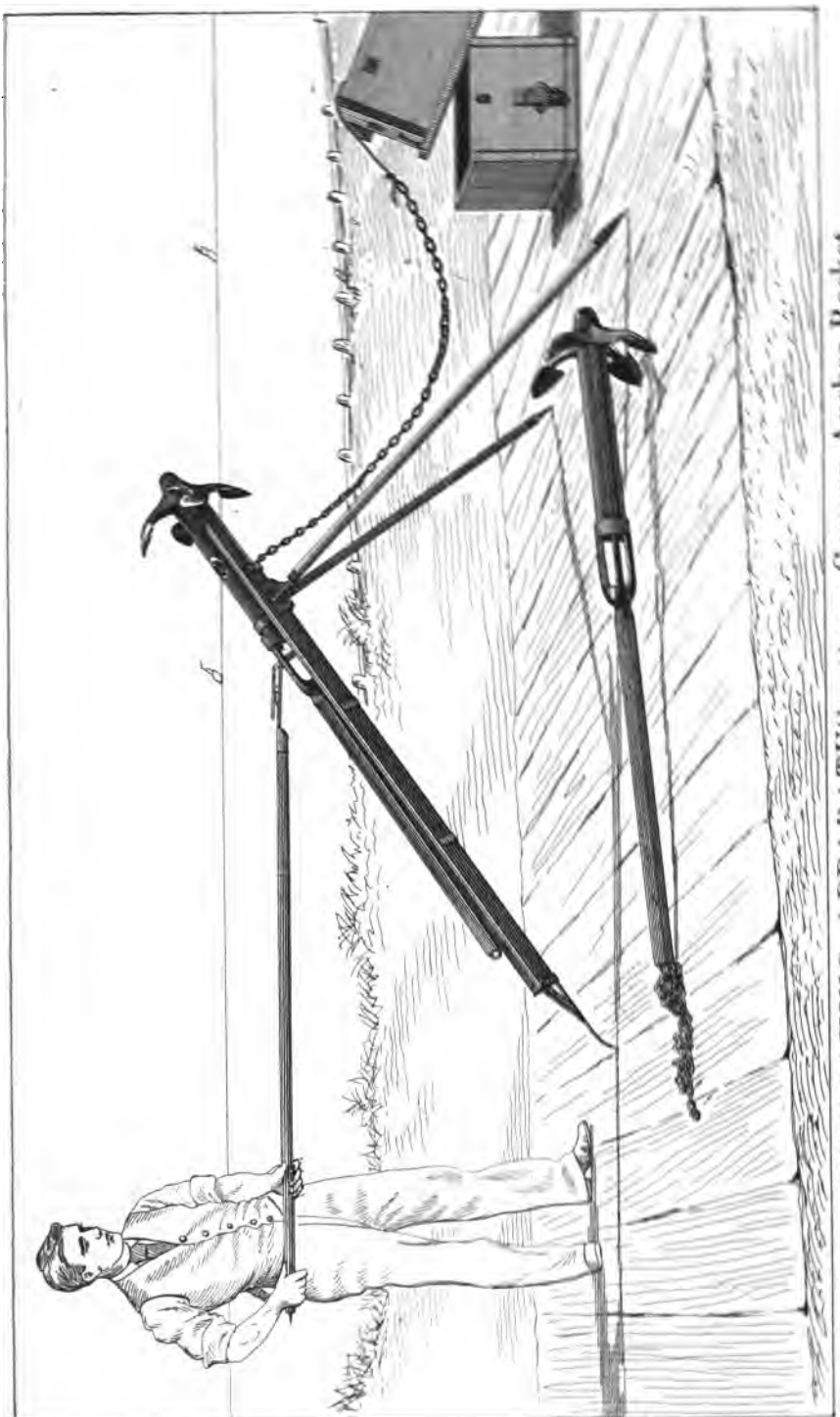


LIFE-SAVING APPARATUS.—Russian Rocket System.



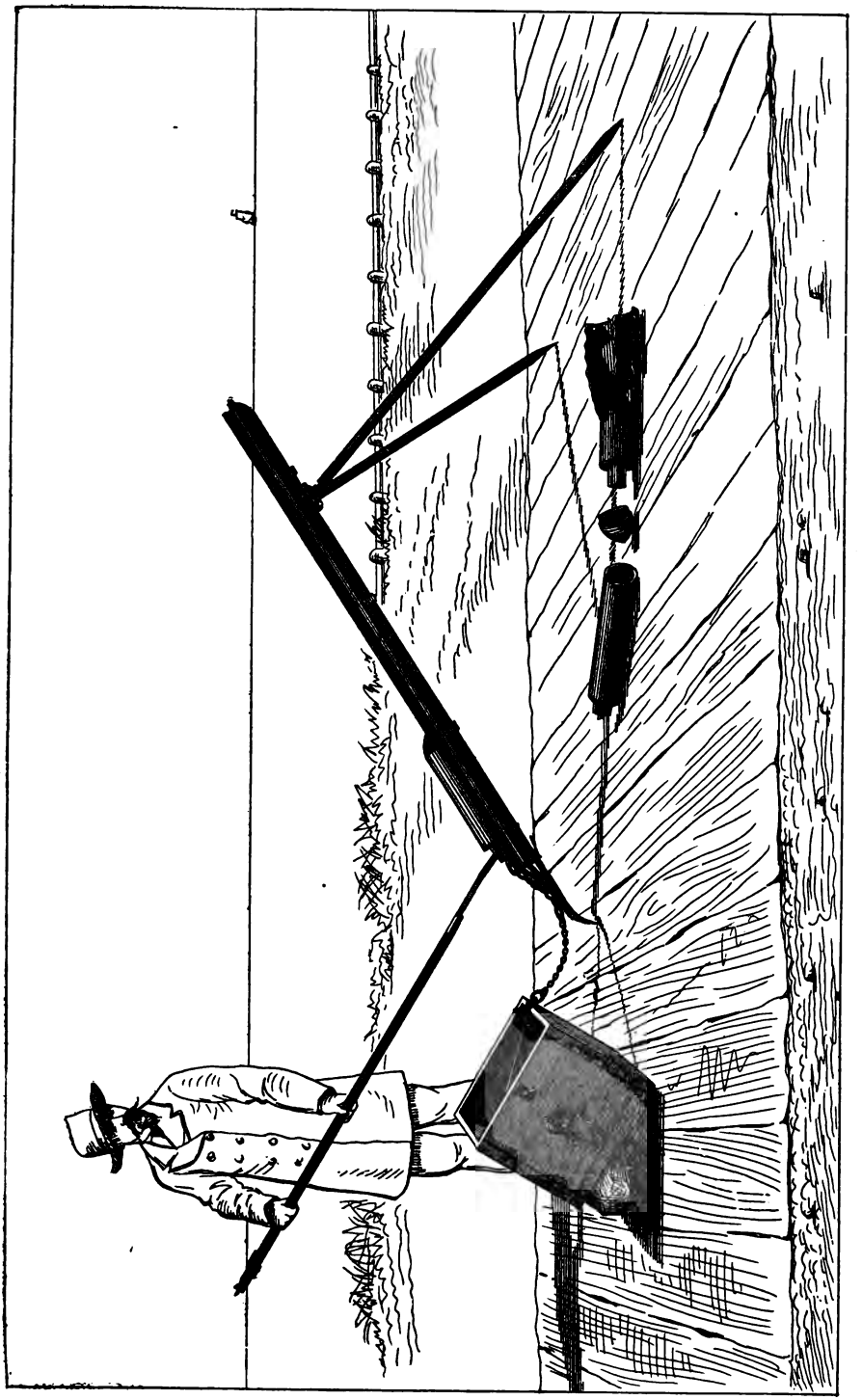
LIFE-SAVING APPARATUS.—5 cm. German Rocket System.

LIFE-SAVING APPARATUS.—8 cm. German Rocket System.



LIFE-SAVING APPARATUS.—8 cm. German Anchor Rocket.

LIFE-SAVING APPARATUS.—English Rocket System.



LIFE-SAVING APPARATUS.—Hooper Rocket.

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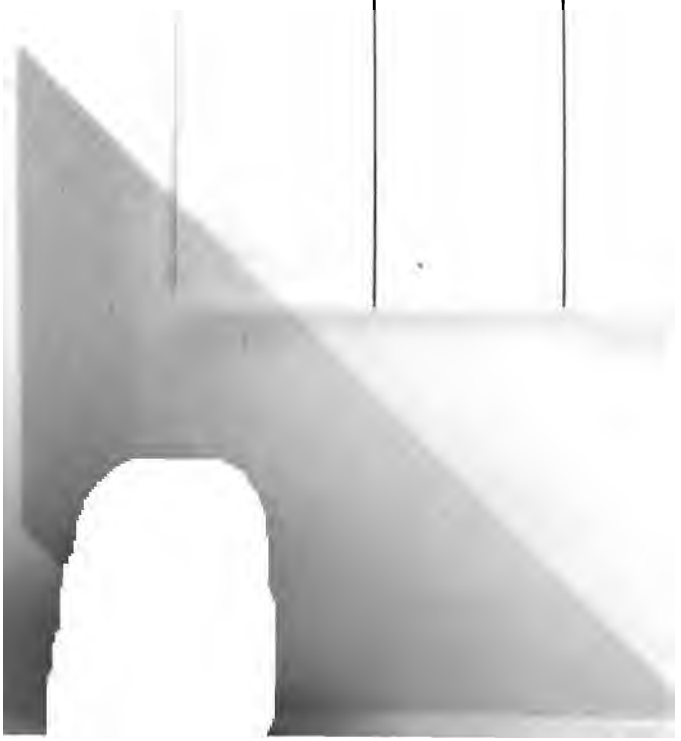

L87 Lyle, D.A. 9214
L96 Report on foreign
1880 life-saving apparatus

NAME	DATE DUE